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**AIR-TO-AIR COMBAT EFFECTIVENESS OF
SINGLE-ROLE AND MULTI-ROLE FIGHTER FORCES**

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE

by

MICHAEL W. FORD, MAJ, USAF
B.S., United States Air Force Academy, Colorado, 1980

Fort Leavenworth, Kansas
1994

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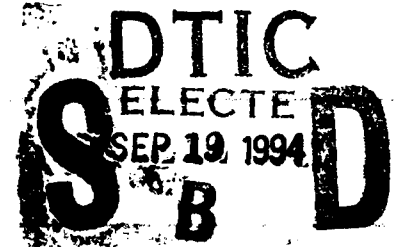
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Master's Thesis 2 Aug 93 - 3 Jun 94

Air-To-Air Combat Effectiveness of Single-Role and
Multi-Role Fighter Forces

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In their continuing efforts to determine how best to meet all global military challenges, U.S. Air Force leaders have elected to discontinue fielding fighter forces dedicated exclusively to air-to-air combat. Driven almost entirely by budget considerations, these decisions will result in multi-role forces only partially concerned with air-to-air combat. What impact this restructuring will have on overall U.S. air-to-air combat capability has not been determined, however, and so provides the rationale for this research.

This thesis examines the air-to-air combat performance of various single-role and multi-role fighter forces during past military conflicts. Eleven criteria, ten objective and one subjective, are used to measure and compare these two groups. The objective and subjective analyses together form the basis for determining the relative air-to-air combat effectiveness of these forces.

The comparative analyses used in this research show that single-role fighter forces have consistently outperformed multi-role forces as measured by the criteria used. Therefore, this thesis concludes that single-role air-to-air fighter forces are more effective than multi-role fighter forces in the conduct of air-to-air combat operations.

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Single-Role Aircraft, Air Superiority, Air Supremacy,
Counterair, Air-To-Air Operations

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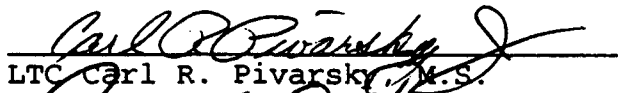
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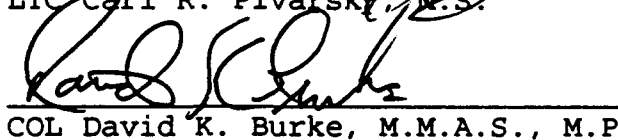
THESIS APPROVAL PAGE


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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other government agency. (References to this study should include the foregoing statement.)

ABSTRACT

AIR-TO-AIR COMBAT EFFECTIVENESS OF SINGLE-ROLE AND MULTI-ROLE FIGHTER FORCES by MAJ Michael W. Ford, USAF, 135 pages.

In their continuing efforts to determine how best to meet all global military challenges, U.S. Air Force leaders have elected to discontinue fielding fighter forces dedicated exclusively to air-to-air combat. Driven almost entirely by budget considerations, these decisions will result in multi-role forces only partially concerned with air-to-air combat. What impact this restructuring will have on overall U.S. air-to-air combat capability has not been determined, however, and so provides the rationale for this research.

This thesis examines the air-to-air combat performance of various single-role and multi-role fighter forces during past military conflicts. Eleven criteria, ten objective and one subjective, are used to measure and compare these two groups. The objective and subjective analyses together form the basis for determining the relative air-to-air combat effectiveness of these forces.

The comparative analyses used in this research show that single-role fighter forces have consistently outperformed multi-role forces as measured by the criteria used. Therefore, this thesis concludes that single-role air-to-air fighter forces are more effective than multi-role fighter forces in the conduct of air-to-air combat operations.

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ACKNOWLEDGEMENTS

First and foremost, I extend my heart-felt thanks and appreciation to my wife, Debby. As a sounding board, critic, and editor, her help was invaluable. Without her patience, understanding, and willingness to go the extra mile for our family, I would not have been able to complete this thesis.

I also consider myself very fortunate to have had a truly committed and helpful thesis committee. Lieutenant Colonel Pivarsky, Colonel Burke, and Colonel Edgar all gave willingly of their time and expertise throughout this research effort. They kept me focused on the task at hand and together created an environment within which it was both easy and enjoyable to work.

Finally, I wish to thank the staff of the Combined Arms Research Library. On more occasions than I can count, they went out of their way to help me in the never-ending search for research material. They deserve acknowledgment as some of the unsung heroes of this entire graduate degree program.

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LIST OF ABBREVIATIONS

AAA	Anti-Aircraft Artillery
AFB	Air Force Base
AFSA	Air Force Safety Agency
ATACMS	Army Tactical Missile System
ATF	Advanced Tactical Fighter
AVG	American Volunteer Group
BVR	Beyond Visual Range
CAP	Combat Air Patrol
CAS	Close Air Support
CINC	Commander-In-Chief
DOD	Department Of Defense
FEAF	Far East Air Forces
FIW	Fighter Interceptor Wing
GCI	Ground Controlled Intercept
IAF	Israeli Air Force
PACAF	Pacific Air Forces
Pk	Probability Of Kill
SAM	Surface-To-Air Missile
SEAD	Suppression Of Enemy Air Defenses
SPO	Systems Program Office
TAC	Tactical Air Command

TACTS	Tactical Aircrew Combat Training System
TFS	Tactical Fighter Squadron
UNEF	United Nations Emergency Force
USAF	United States Air Force
USAFE	United States Air Forces In Europe
USMC	United States Marine Corps
USN	United States Navy
VID	Visual Identification

CHAPTER 1

INTRODUCTION

Introduction

Never have a people been as generally uncertain about the future of the world in relation to war than the present generation.¹ And no where is this uncertainty seemingly more evident than in the United States Department of Defense (DOD). Senior military and DOD civilian officials find it increasingly difficult to keep abreast of the myriad of far-reaching changes in the international political-military environment. Efforts to articulate a new national military strategy have forced all the military services to critically examine the roles they can and will play in the emerging defense paradigm. Further, massive budget cuts have left service planners looking for ways to carry out a host of new and diverse missions with a continually decreasing slice of the national budget.

More specifically, the U.S. Air Force (USAF) now finds itself in the position of still having to conduct the full spectrum of tactical air missions, but with a shrinking and aging force. As a result, fighter forces that at one time specialized in operations in only one major mission category are now viewed as anachronisms. Major General Larry

Henry, of the office of the Air Force Deputy Chief of Staff for Plans and Operations, recently stated the official Air Force position that "to some extent, all our fighters will be multi-role fighters."² Many senior leaders argue that we simply cannot do all that is asked of us unless we multi-mission task all fighters remaining in the smaller base force.

Of particular importance to this thesis is the impact this policy will have on the USAF air-to-air fighter force. The Air Force has employed dedicated, single-role F-15C air-to-air fighter squadrons since 1975, and until quite recently had planned to continue to do so with the follow-on F-22 Advanced Tactical Fighter (ATF). However, initiatives are now being made to add the Suppression of Enemy Air Defenses (SEAD) mission to the F-15 Force, and the full spectrum of air-to-ground missions to the F-22 force.³ These efforts represent a fundamental departure from the current USAF concept of structuring and tasking air-to-air fighter forces.

Problem Statement

Changes as relatively significant as those planned for these forces cannot be made without examining the attendant impact on the overall aerospace control effort. Air Force doctrine stresses the primacy of aerospace control and warns that "a reduction in control threatens every mission, campaign, and type of force."⁴ Major General Richard

Hawley, testifying recently before Congress, described the situation in this manner:

Control of the air or air superiority is an absolute necessity. Since the German attack on Poland in 1939, no country has won a war in the face of enemy air superiority, and no defense has sustained itself against an enemy who has had air superiority. Conversely, no state has lost a war while it maintained air superiority, and attainment of control of the air consistently has been a prelude to military victory.⁵

And because air-to-air fighter operations play a major role in the overall campaign for dominance of the air, changes to the air-to-air force may have a far-reaching impact on all military operations.

At issue then is the consequence of adding new and different mission tasking to those units responsible for achieving and maintaining air superiority. All USAF efforts to add SEAD or air-to-ground missions to the air-to-air fighter force have been driven by the scarcity of defense funding. What has been lacking is any meaningful discourse on the impact of multi-role tasking on combat capability. Rather, the underlying assumption in virtually all current writing on this subject is that additional tasking will not adversely impact our ability to conduct air-to-air missions.

When USAF Chief of Staff General Merrill McPeak was recently asked about the impact of adding air-to-ground missions to the F-22 force, he said: "I don't think it's a big issue that will require a lot of extra training or flying hours in squadrons."⁶ It is well that General McPeak

believes additional flying time will not be necessary in the future because, in fact, these hours will not be forthcoming. Recently released USAF numbers show that flying time for active duty tactical fighter aircrews will decline slightly in 1994.⁷ For the future, Air Force officials hope at best to be able to maintain flying hours at levels approximating those of the past; certainly no increases are envisioned.

The basic problem with such assumptions is that they presuppose a knowledge of how much air-to-air capability the U.S. will need in the future. They further assume that multi-role units will be as capable as current single-role air-to-air units in delivering the necessary combat capability. However, no one has determined how much combat capability will be enough to effectively deal with future threats. Only time and an evaluation of future operations can provide this knowledge. Nor is it sufficient to simply assume multi-role units will be as proficient in air-to-air operations as those that specialize in them. Common sense, in fact, would suggest just the opposite. Therefore, this thesis will examine in detail the relative air-to-air combat effectiveness of single-role versus multi-role fighter forces.

Research Question

Are single-role air-to-air fighter forces more effective than multi-role fighter forces in the conduct of air-to-air combat operations?

Background

The existence of a permanent, dedicated single-role air-to-air fighter force in the USAF is a relatively recent occurrence. Throughout most of the USAF's history, multi-role fighter forces have been the norm and have tended to resemble the swing role air-to-air and air-to-ground fighter units typical of those employed during World War II.⁸ In fact, with the exception of the F-15C and the dedicated continental air defense interceptors, every fighter ever flown by the USAF has been used to drop bombs and attack ground targets.⁹ Therefore, it has been generally true that fighter units tasked with air-to-air missions have also been concurrently tasked with air-to-ground missions.

However, unit specialization in air-to-air combat for limited periods of time has occurred on numerous occasions. In Vietnam, Korea, and World War II, certain units within the fighter community have been tasked with engaging solely in air-to-air combat.¹⁰ In each case, commanders had determined the air threat to be significant enough to warrant a more concerted friendly air-to-air effort. As a result, unit air-to-ground tasking was suspended so that these units could focus all their efforts on air-to-air operations. When and if the air-to-air threat was neutralized, these units then reverted to their former multi-role status.

Despite these times of short-term emphasis on the air-to-air aspect of the air campaign, a sustained long-term emphasis was not made before Vietnam:

To informed observers it was ironic that the importance of air-to-air, eyeball-to-eyeball combat in aerial maneuvering as a primary function of gaining and maintaining air superiority was so soon discounted after both World War II and the Korean conflict....In Tactical Air Command (TAC) the idea that enemy aircraft would be destroyed on the ground worked against any development of an air-to-air fighter while the idea of flexibility of air power mitigated against the idea of single-purpose fighters.¹¹

The Air Force view of air-to-air operations changed significantly, however, on the basis of Air Force experiences in Vietnam.

In May 1965, General John P. McConnell, USAF Chief of Staff, approved and sent to all commands a paper entitled "Air Force Doctrine on Air Superiority," which stated the following:

Enemy airpower is destroyed in two ways: in the air and on the surface. Both methods are essential parts of counterair operations and should be carried out concurrently. Regardless of the tactical air task or mode of attack, survival of the fighter aircraft we commit is at some time likely to hinge on air-to-air capability. Consequently, if either air-to-air or air-to-surface attacks are to succeed with attrition acceptable to us, we must provide aircraft, armament, and training which will succeed in air-to-air combat against the best enemy aircraft.¹²

Thus, for the first time senior Air Force leaders acknowledged the critical importance of air-to-air combat in the overall campaign for air superiority. No longer was it a given that U.S. air power would seek out enemy air forces and

supporting infrastructures and utterly destroy or neutralize them on the ground. Political and technical constraints could create situations that necessitated sustained and continuous air-to-air combat as the only means of reducing enemy air power.¹³ Therefore, although the exact nature of future operations could not be predicted, the official USAF position held it prudent to maintain a highly competent air-to-air fighter force.

The most significant manifestation of this change was the type of fighter the USAF developed for the air-to-air role. General Gabriel Disoway, commander of TAC in 1965, stated that "the philosophy that you are going to build one airplane to do everything" might have been all right in World War II but was no longer applicable.¹⁴ This shift toward aircraft specialization became policy shortly thereafter. In May and June 1968, General McConnell testified on the need for specialization before the Preparedness Investigating Subcommittee of the Senate Committee on Armed Services:

We believe that the basic requirement is for a balanced force consisting of a family of weapons systems, each designed to do one mission extremely well, and one or more other missions credibly well...the force should include [an] aircraft [that] is going to be an air superiority fighter. Its purpose will be to gain air superiority over the enemy and absolute air supremacy over the battlefield. We do not want to degrade it for anything else.¹⁵

Not surprisingly, such an endorsement by senior Air Force leaders gave rise to a variety of single-purpose, specialized fighter aircraft. In this category are the RF-4

for reconnaissance, the F-4G for SEAD, the A-10 for Close Air Support (CAS), and the F-15A/C for air-to-air combat. And consistent with top-level guidance, the F-15 was designed to be not just a dedicated air superiority fighter, but, as the original F-15 Systems Program Office (SPO) director put it in 1969, "the best air-to-air fighter that is humanly possible."¹⁶

Simply producing a superior fighter does not, however, guarantee success in combat. Steve Ritchie, the Air Force's first ace in Vietnam, commented that:

The pilot most likely to succeed is the one most highly trained. Stated another way, a superior pilot in an inferior aircraft will defeat an inferior pilot in a superior aircraft.¹⁷

The truth of this statement was borne out by the relatively poor showing of U.S. fighter forces in air-to-air engagements throughout the conflict in Vietnam. During the time between the end of the Korean war and many years into the conflict in Vietnam, air-to-air training was virtually non-existent in U.S. fighter squadrons. Although not the sole cause, this almost total lack of adequate training goes far toward explaining how Vietnamese pilots in generally inferior aircraft obtained such relatively good results in air-to-air combat with U.S. forces.¹⁸

In 1972, the Air Force held a Tactical Fighter Symposium to bring together experts in the fighter community to identify current shortfalls and recommend corrective action. One of the major findings at the symposium was that

a critical lack of effective training was taking place in fighter units. This finding led to the group's recommendation, widely endorsed by Air Force leadership, for much more realistic and challenging air-to-air training programs.¹⁹ As a result, overall air-to-air combat training at the squadron level, in formal advanced flying school programs, and in major joint and combined exercises became, and remains today, the most rigorous and realistic in the world.

The combined result of these efforts was the creation of the USAF's single-role, F-15C air-to-air fighter force, portions of which were the first contingent deployed to Saudi Arabia during Desert Shield. It was this force that shot down 36 of the 41 Iraqi aircraft destroyed during Desert Storm (2 of the other 5 Iraqi losses were to a Saudi F-15C), while sustaining no combat losses of its own.²⁰ And it is this force that will undertake the SEAD mission in the near future. Although the extent to which F-15C units will fly air-to-air versus SEAD is yet to be determined, its single-role status will no longer be maintained.

Notwithstanding its performance in the Gulf War, the F-15C is one of the oldest elements of the fighter force mix in the USAF and has long been planned for replacement by the F-22 ATF.²¹ Although inherent air-to-ground capability had always been planned for the F-22, it, too, had been intended,

since its conception in 1981, as a single-role air-to-air fighter.²² However, this is also no longer the case.

Lieutenant General John Jaquish, one of the key figures in the F-22 acquisition and development process, recently stated that the F-22 with an air-to-ground capability will be a key component of our future force structure and will be used in both air-to-air and ground attack roles.²³

Clearly, the Air Force is now coming around full circle in terms of air-to-air fighter force structuring. No longer will the Air Force provide assets and crews dedicated solely to the air-to-air role. Instead, we now see a return to the concept of a completely multi-role fighter force, many units of which will conduct air-to-air to varying degrees. What impact this restructuring will have on air-to-air combat capability is unknown. However, by comparing past combat performance of single-role and multi-role units, future USAF air-to-air effectiveness may be more reasonably predicted.

Definitions

Single-Role Aircraft: As already discussed, only a very few fighter units have ever existed that from their inception were or are dedicated solely to air-to-air combat. Instead, most conflicts have produced a fighter unit forced by need to transition from a traditional multi-role status to a focused emphasis on air-to-air combat. Therefore, in order to facilitate the basic analysis of this thesis, both of

these types of fighter units fall into the "single-role" category.

Air Superiority: Central to the issues addressed in this thesis is the concept of air superiority. As defined in Joint Publication 1-02, "air superiority" is

that degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.²⁴

Air superiority is a minimum requirement and generally describes a situation existing in a specific area and for a limited duration.

Air Supremacy: This term, used frequently in relation to Operation Desert Storm, refers to a degree of air superiority in which the enemy is incapable of "effective," as opposed to "prohibitive," interference.²⁵ It should be noted, however, that air supremacy involves extreme efforts and has often proven unobtainable. This has been the case against formidable opponents, such as the Japanese Air Force of World War II; against less formidable enemies operating from sanctuaries, such as the Chinese Air Force during the second phase of the Korean War; and against minor powers whose equipment is supplied by a noncombatant third power, such as in Vietnam.²⁶

Counterair: Counterair is the term the USAF uses to describe all missions whose objective is gaining control of the "air" portion of the aerospace environment.²⁷ These

missions may be either offensive or defensive in nature, and may occur deep in enemy territory or well into our own. Examples of counterair missions include a U.S. Navy Tomahawk cruise missile launch against an enemy command and control network; Army Tactical Missile System (ATACMS) attacks against fixed surface-to-air missile (SAM) sites; F-4G SEAD operations against SAM and anti-aircraft artillery (AAA) sites; F-16 strafing of enemy aircraft parked on an airfield; and F-15 air-to-air dogfights against enemy fighters. The counterair determination is based on the intent of the mission, not the weapons system used to accomplish it.

Air-to-Air Operations: The air-to-air operations discussed in this thesis collectively constitute, therefore, one of several methods used to obtain and maintain air superiority or air supremacy. Air-to-air operations include offensive sweep missions into enemy territory to seek out and destroy enemy aircraft; defensive Combat Air Patrol (CAP) missions in friendly airspace protecting a geographic point or area against enemy airborne attack; escort and protection of friendly aircraft conducting ground attack, SEAD, and other offensive missions in enemy territory; and protection from enemy fighter attack of high-value friendly aircraft operating in both friendly and enemy airspace.

Limitations

This thesis has been limited by the inability to travel to certain locations to conduct research. After

requesting information from The Air Force Historical Research Agency at Maxwell Air Force Base (AFB), Alabama, I was informed that due to very heavy workloads my requests could not be met. I was, however, offered the opportunity to conduct research in person. Unfortunately, this was not possible. Similarly, I requested information from the Air Force Safety Agency (AFSA) at Kirtland AFB, New Mexico. Although AFSA personnel agreed to process my request, they were unable to locate any pertinent information in the brief time allotted for a search of their archives.

Delimitations

A fundamental delimitation is the exclusion of all but combat fighter operations. The emphasis of this thesis is on the performance of fighter squadrons in actual combat, as opposed to peacetime training or exercises. It is only in the crucible of combat that the bottom-line effectiveness of any military unit can be analyzed. And since this effort is ultimately concerned with the impact of force structure changes on the effectiveness of future combat operations, only past air-to-air combat will be evaluated.

I have limited my research to aerial combat operations of World War II and later conflicts. Although some fighter units before this time were dedicated primarily to air-to-air combat, their operations bear little resemblance to those of today. Training for combat was so inadequate, reliability of aircraft was so poor, and record

keeping was so sporadic that determining why combat operations developed as they did is impossible to do. Therefore, the relevance of these operations to present concerns is difficult to assess.

I have not been able to study every fighter unit that has ever engaged in air-to-air combat. Instead, I have focused my efforts in two areas. The first is a general study of the vast majority of fighter squadrons that together form the multi-role baseline for this thesis. The second is a detailed study of those fighter units that were either established as single-role air-to-air squadrons or those that became single-role units through training and emphasis on air-to-air combat.

To illustrate this delimitation, in examining the U.S. air campaigns in Vietnam, I have not detailed the operations of the USAF's 13th Tactical Fighter Squadron (TFS), but I have included detailed information on the U.S. Navy's F-8 Crusader squadrons. The reason is that the 13TFS was a typical multi-role fighter unit whose record forms part of the multi-role unit baseline data. Conversely, the Crusader squadrons are prime examples of units that effectively became single-role due to their emphasis on air-to-air combat.

Literature Review

The overall amount and quality of source material bearing on this research topic is more than adequate. Air-

to-air combat is a fascinating subject for many, and much has been written on it. Similarly, the desire to increase, or at least measure, combat effectiveness has also given rise to serious research in this area. Nevertheless, I have found nothing to indicate that a comparison of single-role and multi-role unit air-to-air effectiveness has been undertaken. Generally, this subject has either been ignored completely or one type of force has simply been assumed to be the most effective.

The research material I have sought and used falls into three major categories. The first is that pertaining to the current U.S. military situation in general and USAF force restructuring in particular. The second category includes material listing, describing, and evaluating possible measures of air-to-air combat effectiveness. Lastly, I have conducted extensive historical research on unit performance in air-to-air operations.

Current U.S. Military Concerns

The most beneficial sources on current military concerns, as well as those for the future, have been professional journals, magazines, newspapers, and Congressional records. Air Force Magazine, The Airpower Journal, Military Review, The Air Force Times, The Navy Times, Jane's Defence Weekly, and The Joint Force Quarterly have all proven to be excellent sources. Each of these publications benefits from the extensive military knowledge

of both staff and guest writers. Their critical and fact-filled essays on today's key military issues have proven quite relevant and helpful.

Congressional testimonies by DOD officials, Unified Commanders-in-Chief (CINCs), and USAF leaders have provided key insight into current thinking on future U.S. military operations. Those called before Congress have sought to clarify service roles and missions within the new national military strategy. Further, they have attempted to provide convincing evidence of the need to begin, or continue, a variety of weapons system acquisition programs. The totality of this testimony has helped present a more focused vision of how air-to-air combat will fit into the larger scheme of joint and combined theater warfare.

Criteria for Measuring Air-to-Air Combat Effectiveness

Information on measurement criteria has come from a mix of books, periodicals, and published and unpublished research efforts. Books and older periodicals have provided insight on how those involved in a particular conflict judged their own performance. Rather than clearly stating a measure of combat effectiveness, these sources point indirectly to criteria for success the experts of the day felt were important. Taken in total, certain supportable measures can be discerned.

A variety of research efforts in recent years has been designed to determine predictive measures of aerial

combat performance. These efforts seek to identify measurable aspects of performance in a ground-based simulator environment that can be used to accurately predict actual airborne combat effectiveness. The Air Force's Armstrong Laboratory and Human Resources Laboratory, and the Navy's Aerospace Medical Research Laboratory have all conducted such research. While many of the proposed measures have proven unsuitable for various reasons, some are applicable to my own research design for this thesis.

History of Unit Air-to-Air Performance

Again, a variety of sources has yielded relevant information. Each of these, however, has presented only a relatively small insight into a unit's past operations. For example, one source may only place a fighter squadron in a particular location at a particular time. Another source is needed to explain this unit's mission, equipment, training, and tactics. Yet another source may then detail actual combat operations and the outcomes of campaigns and engagements. Only by collating the information from all such sources has it been possible to clearly understand most past unit operations.

Certain books, such as Frank Futrell's Aces & Aerial Victories: The United States Air Force in Southeast Asia 1965-1973, are excellent sources of moderately detailed unit combat statistics. Similarly, many articles found in professional periodicals of the day present general

statistics on the outcomes of combat operations. For the most part, these sources are concerned with broad aggregate numbers, such as total number of aircraft killed or lost, as opposed to unit-specific statistics.

To obtain information on specific units, I have turned to published and unpublished unit histories, combat crew narratives, and published individual diaries. Sources of this type provide insight into day-to-day unit operations and give enough detail to help determine if a particular organization is appropriate for inclusion in this thesis. As previously noted, however, these detailed histories are not readily accessible.

Finally, I have used numerous books, periodicals, and unpublished theses and monographs as sources of conceptual information on the single versus multi-role fighter issue. Richard Hallion's discussions in both book and periodical on the subject of USAF tactical airpower development have proven particularly helpful in understanding some of the major factors bearing on my subject. Similarly, General William Momyer's Airpower in Three Wars (WW II, Korea, Vietnam), presents an excellent framework for understanding the recent history of U.S. tactical fighter employment. Various theses have also been useful for evaluating the concept of air superiority and the place of fighter units in the overall counterair campaign.

Methodology

The information in this thesis is presented in a sequential manner intended to support a comparative analysis of single-role and multi-role units in the conduct of air-to-air operations.

Chapter Two lists, defines, and amplifies criteria that have been used in various studies to measure air-to-air combat effectiveness. These criteria come from many sources and vary significantly in their relationships to air-to-air combat. Therefore, each is explained in enough detail to show why it is addressed and what it is actually measuring. Eleven criteria are addressed in this chapter; ten are supported by empirical information, and one is supported by subjective analyses.

Chapter Three provides historical data and is divided into two major sections. The first section contains empirical data on the performance of both single-role and multi-role fighter units. Multi-role units are addressed generally, and the statistics and background information presented apply to this group as a whole. Single-role units are discussed in much greater detail. In addition to presenting empirical data on each single-role fighter unit, this subsection also contains narrative information on unit operations and why these operations distinguish each unit as single-role in nature.

The second section of Chapter Three is a treatment of the single-role versus multi-role air-to-air fighter issue from a subjective perspective. This section uses authoritative statements and observations to trace the development of airpower thinking and doctrine on the specialization issue. To the extent possible, information in both sections relates directly to one or more of the measurement criteria established in Chapter Two.

Chapter Four is an analysis of the historical information presented in Chapter Three relative to the measures of effectiveness developed in Chapter Two. First, the available empirical data is analyzed relative to each of the objective measures. The data on each criterion is individually evaluated to determine whether single-role or multi-role fighter units emerge as being the most effective in air-to-air combat.

Following this empirical analysis is a subjective analysis of each of the units based on the authoritative doctrinal information presented in Chapter Three. The results of the empirical and subjective analyses are then compared with one another, and a final determination is made on whether single-role or multi-role fighter units are the most effective in conducting air-to-air combat operations.

Chapter Five is the final chapter and presents the overall conclusion stemming from the analysis in Chapter

Four. This conclusion answers the thesis question. Finally, this chapter makes recommendations for further research.

Significance of the Study

Alvin Bernstein, editor-in-chief of the newly published Joint Force Quarterly magazine, commented in his inaugural issue that "just as there is no substitute in combat for trial by fire, so the best ideas can only emerge after they too have undergone the appropriate trial by debate."²⁸ Whether the decision to return to a completely multi-role fighter force is one of these "best ideas" is uncertain. What is certain is that this idea has not been thoroughly subjected to a trial by debate. This issue, like many others facing our military forces today, is simply too important not to debate.

By establishing whether single-role air-to-air fighter units are more effective than multi-role fighter units in the conduct of air-to-air combat, a sound ground work for force structuring can be laid down. If multi-role forces are equally effective, then current USAF initiatives should have no adverse impact on future combat capability. If, however, multi-role units are not as effective as single-role forces, then Air Force leaders can use this knowledge to more intelligently plan for the required future air-to-air force structure.

This issue has potential ramifications for many others besides those in the Air Force. General Gordon

Sullivan, U.S. Army Chief of Staff, recently wrote that joint operations are not only more efficient than single-service operations, but also will be the future norm at every level of command.²⁹ This jointness can only serve to increase the reliance that all military services already have on the Air Force for providing the levels of air superiority necessary for carrying out other combat operations. Nor is this reliance unique to the U.S. sister services. General McPeak testified before Congress that the high-tech F-22 fighter force was essential because, while our allies bring low-tech aircraft to any alliance, they rely on us to provide the state-of-the-art, high-tech forces necessary to ensure air superiority.³⁰

Perhaps the most significant contribution this work may make is to the fighter acquisition process. The USAF goal is to retire each fielded fighter type at the 22-year point.³¹ Since the time from fighter concept development to delivery is now approximately 20 years, a service decision on a particular fighter represents a staggering 40-year commitment. A determination on single versus multi-role air-to-air fighter capabilities can only help to ensure the U.S. acquires the fighter force we truly need.

The bottom line is air-to-air fighter forces play a significant role in the campaign for air superiority, which, in turn, is essential for overall victory. General Bruce

Holloway warned us not to lose sight of the importance of air superiority when he wrote:

A generation of American fighting men has almost forgotten what it is like not to have air superiority - what it is like to lose mobility except by night; to be cut off from supplies and reinforcements; to be constantly under the watchful eye of enemy reconnaissance aircraft; to be always vulnerable to strafing and bombing attacks; to see one's fighters and bombers burn on their hardstands; to be outnumbered, outgunned, and outmaneuvered in the air.³²

It is my hope that this thesis will provide helpful insight for those who are now or may one day be tasked with determining the tactical fighter force needs of our country.

CHAPTER 2
CRITERIA FOR MEASURING AIR-TO-AIR
COMBAT EFFECTIVENESS

Introduction

Criteria for measuring the success of combat operations spring from two primary sources. The first is the body of research efforts that looks to history and seeks to evaluate the relative effectiveness of past military organizations, plans, and operations. The second is that group which attempts to predict future battlefield outcomes based on controlled simulations or observations of current operations.

For the most part, both types of research involve criteria that can actually be used for either historical analysis or for efforts predicting future combat outcomes. Therefore, I have used both as sources for my research. Regardless of the source, however, all of these criteria are objective in nature and concern measures of positional advantage, weapons employment, or the potential for maneuvering.¹ They are used to compartmentalize and quantify combat actions in order to support direct comparison. But combat operations, and more specifically air-to-air combat operations, are neither easily quantifiable nor measurable.

For this reason, a purely empirical analysis of past combat operations will not create a complete and wholly accurate picture. While numbers and statistics are important and can reflect accurately on combat effectiveness, a complete analysis will depend also on background rationale and subjective input from those involved. Therefore, a criterion must also exist that supports a subjective analysis.

This chapter addresses both subjective and objective measures by which air-to-air combat effectiveness can be evaluated. Each focuses on either a different portion of the tactical air battle or stops at a different point in time along the air-to-air engagement spectrum. Further, some reflect more strongly than others on causal factors, such as aircraft capabilities, weapons, or aircrew proficiency. Regardless, all have relevance to the study of air-to-air combat effectiveness.

Subjective Criterion: Mission Objective Accomplishment

Webster's Dictionary defines "effectiveness" as "the quality of being effective," which in turn is defined as "producing a definite or desired result; efficient."² No meaningful discussion of air-to-air combat effectiveness can take place, therefore, without first determining what result or results this combat is designed to bring about. For air-to-air operations, like all combat operations, these results are expressed in terms of mission objectives.

As discussed in Chapter One, all air-to-air missions contribute in some manner to the battle for aerospace control. But every mission is unique and, therefore, has unique objectives, as do flights and even individual fighter aircrews within a particular flight. These objectives are determined by each mission commander or flight lead based on his combined assessment of higher headquarters' tasking, his available forces, the expected threat, and the overall situation. Once determined and briefed, mission objectives dictate all subsequent actions by all members of the mission.

It follows, then, that in the most basic sense a mission that accomplishes its stated objectives is effective, while the mission that fails to meet its objectives is not effective. For the individual flight lead, this assessment is a simple matter of comparing performance to objectives immediately after the mission. However, these individual mission objectives and aircrew responsibilities are virtually never recorded. Therefore, the detached researcher attempting to make an evaluation of effectiveness long after the fact and without a knowledge of mission objectives, must acknowledge his effort as being fundamentally suspect. To understand why this is so, consider the following detailed example.

A flight of two fighters, leader and wingman, is tasked as part of a bomber escort mission. When the mission is over, three bombers have been destroyed and the fighter lead is dead, killed by an unobserved enemy fighter; the

wingman survived and achieved two enemy kills. Knowing nothing else, one would most likely conclude the mission a failure overall because enemy fighters not only shot down three friendly bombers, but also the fighter lead. One might also suggest that the fighter wingman acquitted himself well by surviving and killing two enemy fighters.

But view these results in light of this flight's mission objectives and the actual events. The flight lead had stated that the flight must destroy or drive off at least 50% of the enemy fighters posing a threat to the formation of sixteen bombers the flight was to protect. The lead further stated that his wingman's primary objective was to remain visual with and protect him while he engaged the enemy fighters. When eight enemy fighters attacked, the leader engaged with and was able to turn away four of them before being shot down himself. But the wingman lost sight of lead early in the engagement and eventually turned away to pursue and shoot down two of the departing fighters. The remaining four enemy fighters were then able to close with and shoot down three bombers.

Viewing these results in light of the mission objectives leads one to a much different conclusion about the flight's effectiveness. Although he did not kill any enemy fighters, the lead did in fact meet his primary objective of driving off 50% of the enemy force. Conversely, the wingman

failed completely because he neither protected his leader nor the bombers, but instead lost sight and moved off to engage enemy fighters that were no longer a threat to the mission. Clearly, the assessment of mission effectiveness differs greatly depending on the extent of background information available on mission objectives.

Although few, there are those who can, in fact, make a valid and meaningful assessment of air-to-air combat effectiveness based on mission objective accomplishment. Commanders, participants, and other trained observers who understand the intricacies of aerial combat and who have observed unit performance over long periods of time can draw highly accurate conclusions from their observations. When doing so, they are not basing their statements on any one objective criterion. Rather, they are making subjective assessments based on their total knowledge of and intimacy with the unit or subject of interest.

As the previous example points out, any purely objective evaluation of combat effectiveness cannot be considered complete in itself. Therefore, although wholly subjective in nature, evaluations of air-to-air combat effectiveness based on mission objective accomplishment can contribute greatly to this process and are arguably the most meaningful and reliable of all.

Objective Criteria

Kill-To-Loss Ratio

This criterion is by far the best known and most widely used. From the time of the earliest dogfights in World War I, air battles and fighter units have been evaluated in terms of how many enemy aircraft have been shot down versus how many friendly aircraft have been lost in the process. To a large extent, this has become the definitive standard of comparison because it is the most easily measured.

With only few minor differences, the terms "kill" and "loss" mean the same today as they have throughout the history of aerial warfare. The definition of "kill" used as the basis of awarding aerial victory credits in Vietnam is probably the most succinct:

An enemy aircraft was considered destroyed if it crashed, exploded, disintegrated, lost a major component vital for flight, caught fire, entered into an attitude or position from which recovery was impossible, or its pilot bailed out. The claim had to be substantiated by written testimony from one or more aerial or ground observers, gun camera film, a report that wreckage of the enemy aircraft had been recovered, or some other positive intelligence that confirmed its total destruction.³

Conversely, a friendly aircraft has been considered a combat "loss" if any of the same descriptive conditions apply. Implied within this definition is the requirement that the conditions described must have occurred during an engagement between opposing airborne forces. Therefore, although a friendly fighter shot down by a SAM, for example,

is certainly a loss, it is not an air-to-air combat loss and does not apply to this discussion.

This criterion is also the most complete because it evaluates the effectiveness of the totality of the air-to-air fighter system (i.e., the aircrew, the aircraft, the weapon, and the tactic). Poor performance relative to the threat in any one of these areas can easily reverse the outcome of the engagement. Further, kill-to-loss ratios evaluate the entire tactical engagement spectrum because they measure final outcomes. Finally, this criterion is especially valid because it is one of the few that directly compares the performance of opposing forces, unlike most that deal more with one-sided measures of unit efficiency.

However, kill-to-loss ratios can also be misleading. First, many of these ratios do not compare similar operations. For example, kill figures for one side may include destruction of all types of enemy aircraft, including bombers, transports and even manned balloons. Conversely, the loss figures for this same side often include only fighter or fighter-bomber type aircraft destroyed by enemy fighters. This can lead to an "apples and oranges" type of comparison, which has little value for analysis.

Also, kill-to-loss ratios mean little in the short-term. The reason for this is the lack of direct relevance between such a ratio and the objectives of a specific mission. Killing many enemy aircraft while sustaining few

friendly losses does not necessarily equate to mission success. However, over the long-term, the kill-to-loss ratio becomes more relevant because it provides insight into overall unit performance trends and attrition of opposing forces.

Kills Per Engagement

This criterion is a measure of how many enemy aircraft are killed each time an engagement with one or more occurs. It does not measure the tactical elements leading to the fight, but simply evaluates performance after the fight has begun. Generally, an engagement is considered to have begun either when one fires a weapon at an enemy aircraft or when one must defend against an enemy weapon fired at him. Also, this criterion is unilateral; it makes no direct assessment of enemy offensive capabilities nor any comparison between forces.

"Kills per engagement" is a constructive measure in that it helps the researcher compare various units on a more level basis by taking into account the element of "opportunity."⁴ For example, one unit in a particular conflict may have 100 kills to its credit, while another similar unit in the same conflict has only 15 kills. But if the first unit scored its victories in a total of 500 engagements, while the second unit fought only 20 engagements, the latter is clearly more effective. History has shown that certain units in every conflict shoulder more

of the air-to-air combat load than others, so this criteria can prove very helpful when evaluating combat effectiveness.

However, "kills per engagement" can also be completely irrelevant to the issue of combat effectiveness. Mission accomplishment for many air-to-air mission categories is not dependent at all on killing opposing forces. All defensive counterair missions and many offensive counterair missions fall into this category. These missions seek to stop friendly ground or airborne targets from being attacked; they are concerned solely with force survival, not large kill tallies. If the protecting fighter forces can drive enemy aircraft away or force attackers to jettison bombs prior to their targets, then such missions are effective even when not a single enemy aircraft is downed.

Percentage of Engagements Survived

Survival is, of course, of critical importance in combat operations. An aircraft, and usually more importantly a pilot or aircrew, lost in combat may not be replaceable in the near-term and sometimes not at all.

"Percentage of engagements survived" is concerned only with the defensive aspects of air-to-air combat. The engagement itself may begin from an offensive, defensive, or neutral posture, and roles may change during the course of the battle. Also, shots may be taken by any or all fighters involved; aircraft may even be hit by enemy fire. These factors do not matter, however, for the purposes of this

criterion. If a friendly aircraft is able to make it back and land in friendly territory, aircraft and crew have survived the engagement.

This criterion is generally used when evaluating the human element of air-to-air combat. This is particularly true for fighter units, such as surface attack or SEAD squadrons, that conduct other than air-to-air missions in their primary role. These fighters, some carrying no air-to-air ordnance, are likely to be engaged by enemy counterair fighters and, thus, to begin the engagement from a defensive posture. For them, simply surviving an air-to-air engagement is a major mission objective.

This criterion is useful in that it evaluates survival only in terms of air-to-air engagement outcomes. Measuring overall unit survival throughout a conflict or campaign will not contribute to an understanding of air-to-air combat effectiveness because such a measure will include losses unrelated to aerial combat. This measure can be used to judge unit pilot proficiency in maneuvering relative to enemy fighters, a key element of air-to-air combat effectiveness.

"Percentage of engagements survived" can also be a very misleading indicator of effectiveness. By definition, one is engaged if either shooting at or being shot by the enemy. Therefore, this single criterion could be used to compare one flight that began and ended its engagement

continuously offensive with one that began completely defensive yet survived so long that the enemy departed. This is not to say one flight was more or less effective than the other. Rather, the two events are simply not comparable.

Therefore, the most meaningful manner in which this criterion can be used is to compare survival rates for different units using the same type of engagement start parameters (e.g., offensive, defensive, or neutral). This is easily done in research projects like that at the U.S. Air Force's Human Resources Laboratory, in which relative start positions and survival rates can be easily controlled and measured.⁵ Such measurements are very difficult for combat operations, however, due to the lack of appropriate documentation.

First Shot Opportunity

This criterion measures performance up to the point at which one fighter, on either side, first enters a weapons envelope. This is the first possible time when a missile or gun can be fired within the parameters that "should" result in a hit on the target. As an indicator of offensive potential, which is necessary for victory in the air-to-air combat arena, this measure presents a valid portrayal of overall combat effectiveness.

This measure has been used in two different ways. First, U.S. Navy (USN) research projects conducted in the late 1970s determined that "first shot opportunity" could

actually be used as a fairly consistent indicator of final engagement outcome.⁶ Second, this criterion is another that directly compares friendly and enemy actions in combat. For each engagement, there is only one "first shot opportunity." Therefore, the flight or individual fighter that is able to maneuver to shoot before the enemy can do so is certainly contributing in a positive way to overall mission effectiveness.

Virtually identical is the criterion "actual first shot of engagement." The only difference is that the pilot actually initiates weapons launch or firing. Again, this measure is not concerned with actual weapon performance, but simply with the act of flying to some parameters perceived as suitable for launch, and then doing so.

Percentage Of Engagement Time Offensive/Defensive

The participant in aerial warfare may find himself offensive, defensive, or neutral relative to the threat in terms of position, maneuvering potential, and weapons capability. The neutral status by definition yields no advantage either way. But a measurement of the percentage of engagement time spent either offensive or defensive produces a direct comparison of air-to-air combat effectiveness. This criterion has been used in numerous academic studies and research efforts.

In 1989, the USAF Human Resources Laboratory conducted one such research project designed to formulate a

composite measure of performance for one-versus-one engagements conducted in a flying simulator.⁷ Pilots flew against one another in the simulator, and the time spent by each in offensive and defensive positions was measured. This factor was combined with others to provide one overall assessment of air-to-air combat effectiveness. A similar study carried out by the U.S. Navy's Human Factors Laboratory conducted identical research involving actual training missions flown on an instrumented Tactical Aircrew Combat Training System (TACTS) range.⁸

In these types of research projects, certain basic judgments are made about the meaning of the time spent in a certain status. Typical judgments are: it is better to be offensive than defensive; if offensive, it is better to have a short engagement (achieve a quick kill and get out of the threat area); and if defensive and not able to get offensive, it is better to have a long engagement (the pilot survives for a longer time).⁹ Most, if not all, fighter aircrews would subjectively agree with such judgments.

The primary shortcoming of this criterion is what is easily measurable and applicable in the simulator is not so in a real-world combat flying environment. Aerial combat virtually never involves a single aircraft on either side. Rather, multiple aircraft are involved in large fights that produce situations in which one is offensive relative to one or more enemy aircraft while simultaneously defensive

relative to other threat aircraft. Providing a label for such a status becomes problematic.

Shots Per Engagement

This criterion does not relate to the entire engagement spectrum, but, instead, focuses only on that part of the fight leading to weapons employment. It removes from the evaluation process the performance of the aircrew, aircraft, and weapon after the pilot actually commands missile launch or gun firing. Therefore, this criterion does not directly measure the effect of one's actions on the enemy, but rather the potential to destroy the enemy based on one's ability to take shots.

This criterion differs from "kills per engagement" in that it only evaluates the aircrew and their tactics and does not concern itself with weapons effectiveness. Because the ability of any fighter unit to maintain its aircraft systems and weapons and to employ them accordingly are major aspects of unit effectiveness, this measure is less complete than that of "kills per engagement." However, from the standpoint of specific research into aircrew performance, this criterion places emphasis on the human factor and is, therefore, applicable.

Percentage Of Shots Valid At Launch

This criterion completely removes post-launch weapons system performance from the evaluation process. Instead,

this is solely a measure of aircrew entry into and recognition of valid launch parameters. Because this is solely a measure of the human element of air-to-air combat, it has been included in various studies of aircrew performance.

For example, in 1990 the Institute For Defense Analysis conducted a DOD study investigating the relationship between aircrew experience levels (i.e., number of flying hours) and overall air-to-air performance.¹⁰ Researchers set up a simulation that assumed a probability-of-kill (Pk) of 1.0 (i.e., every shot that was valid at launch killed its target).¹¹ This assumption, typical of such research, removes all but the human factor in the engagement. Therefore, "percentage of shots valid at launch" becomes a direct measure of engagement outcome and, by extension, overall air-to-air effectiveness.

The obvious limitation of this criterion is that no weapon ever made has a Pk of 1.0. In practice, no system works perfectly every time it is used. Therefore, as mentioned previously in regard to others, this criterion is also limited in that it does not evaluate the complete engagement spectrum. By stopping short of a real-world result, this criterion provides only a partial evaluation of air-to-air combat effectiveness.

Kills Per Firing Attempt

This criterion is a measure of how many enemy aircraft are destroyed every time an attempt is made to do so. It is concerned only with the last phase of the tactical engagement and assumes the aircrew has done everything else required to obtain a position from which a shot can be taken. This criterion has historically been used in two distinctly different ways.

First, "kills per firing attempt" is typically used within an organization as a measure of weapons effectiveness. For example, during the war in Vietnam, the USAF 1st Test Squadron in the Philippines, responsible for testing fielded air-to-air missiles, evaluated and tracked various units to determine the reliability and capability of these U.S. weapons.¹² From the standpoint of comparing the combat effectiveness of different units, the criterion, when used in this manner, is of limited value.

The other way in which "kills per firing attempt" is used centers around the abilities of the pilot or aircrew. When concerned with air-to-air missiles, it measures how efficiently the aircrew has achieved and recognized valid firing parameters. When concerned with aerial gunnery, which has traditionally been the case, this criterion measures how skillfully the pilot can maneuver his aircraft relative to the enemy and obtain a tracking solution of sufficient length

to hit the target. When used in this manner, "kills per firing attempt" is a useful measure of unit combat effectiveness.

Unfortunately, combat analyses of "kills per firing attempt" do not usually distinguish between these two uses for this criterion. Therefore, one cannot know if an invalid shot was caused by pilot error or inability, or if the weapon itself did not function properly. Further, weapons effectiveness is also dependent both on the performance of supporting systems onboard the launching aircraft and on the abilities of the weapons load crews. Thus it is possible to have invalid shots for reasons completely unrelated to those with which we are concerned.

This measure can also be misleading because the underlying assumption when using it is that any combination of valid or accurate firing parameters and well-functioning weapons will result in a kill. This is not always the case. Certainly, there have been instances in which aircraft that have been riddled with bullets or that have been hit with air-to-air missiles have not been "killed," but have been able to limp home to be repaired and used again.

Air-to-Air Related Accidents

As discussed previously, an aircraft can be considered "killed" for a variety of reasons. Although one normally pictures aerial dogfights ending with one of the participants "going down in flames," this is certainly not

always the case. Many engagements in every major conflict have resulted in one or more aircraft being killed through accidents caused by operator error.

These accidents are manifested in a number of ways. Certainly the easiest to perceive in combat is impact with the ground. All fighter engagements descend lower and lower as the fight continues due to loss of energy. Eventually, the participants may find themselves literally fighting at tree top height. The slightest lack of concentration or loss of awareness of one's position relative to the ground can and often has resulted in impact with the ground.

Another often seen result of air-to-air combat maneuvering has been an out-of-control aircraft spiraling or spinning to the ground. All aircraft are designed to fly only within a certain prescribed operating envelope. But air-to-air combat is a contest for survival, and the aggressive pilot will push his aircraft to the very limits of this envelope. Unfortunately, the margin for error is often very small, and exceeding designed operating parameters has often resulted in a fatal out-of-control situation.

In addition to pushing his aircraft, a fighter pilot must also subject his body to stresses which man was not created to withstand. Spatial disorientation from operating in a constantly changing three-dimensional fight can easily cause the pilot to lose all sense of direction and attitude relative to the horizon. Also, because modern fighter

aircraft can withstand stresses far exceeding those of the people who fly them, it has become increasingly common for pilots to sustain so many "G" forces that they black out during maneuvering. Both of these situations often result in fatal impacts with the ground.

Finally, significant numbers of air-to-air engagements have ended in mid-air collisions. Although such collisions have certainly occurred in small engagements, they have most often taken place during swirling, confusing fights between large numbers of aircraft on both sides. Many mid-air collisions have occurred with enemy aircraft, but many have also taken place with other friendly fighters, sometimes within the same flight. And more often than not, aircraft are lost and crews are killed in these accidents.

Studies have shown that both overall flying time and time in the particular aircraft of concern are directly related to accident rates.¹³ Generally, the higher one's flying time, the less likely one is to have an accident. By extension, the assumption is that those more proficient in air-to-air maneuvering are less likely to have an air-to-air related accident. Therefore, this criterion can be used to compare the relative air-to-air combat effectiveness of different fighter units.

Incidence of Fratricide

One of the most critical aspects of modern air-to-air warfare is correct identification of one's target. In the

days of gun-versus-gun aerial dogfights, when the target was within a thousand feet of one's guns, this identification was a relatively easy task. But even then, fratricide occurred. As technology has advanced and provided the warrior with weapons that can kill from beyond visual range (BVR), the potential for fratricide has increased exponentially.

This measure once again is intended to evaluate the human aspect of air-to-air combat effectiveness. Obviously, those units with fewer incidences of fratricide are considered more effective than those with more. There is, however, one very fundamental problem with this criterion.

One can reasonably assume that if a pilot knew he was engaging another friendly aircraft, he would not do so. For this reason, no pilot in this situation reports an act of fratricide, but rather his honest belief that he has downed an enemy aircraft. Unless another friendly fighter was witness to this fratricide, the incident will never be reported as such. In the modern age of long-range air-to-air missiles, the likelihood of not reporting this situation as fratricide is even greater. For this reason, "incidence of fratricide" may simply not be accurately quantifiable.

CHAPTER 3
HISTORICAL INFORMATION ON
AIR-TO-AIR COMBAT

Introduction

As discussed in Chapter One, the focus of this thesis is on actual combat operations, as opposed to unit peacetime training or air-to-air combat training exercises. To support this emphasis, this chapter presents information on fighter units of the USAF, U.S. sister services, and those of other countries that have fought combat air battles during and since World War II.

The two primary criteria I have used in deciding whether to include detailed background information on a particular unit have been the availability of data on the unit and the requirement that the unit qualify as single-role in its approach to air-to-air combat. As discussed in Chapter One, a unit need not have been formed originally in the single-role air-to-air combat role to be considered in this thesis as a single-role fighter unit. Rather, the determining factor is a unit's focused preparation for and execution of air-to-air combat over a period of time in a particular conflict.

In some cases, I have not included relevant fighter units because I have been unable to obtain sufficient data on their combat operations. The USAF's 27th Fighter Escort Wing in Korea, and Israeli fighter squadrons that fought in the 1973 Yom Kippur War fall in this category. In other cases, I have excluded units whose operations have been greatly detailed, but which can in no way be considered single-role air-to-air units. This category includes dedicated air-to-ground squadrons, the vast majority of which have experienced little or no air-to-air combat. Finally, multi-role fighter squadron operations are not detailed individually, but instead form part of the overall multi-role data base for the conflict in which they fought.

This chapter is divided into two major sections. The first section deals with the objective aspect of this research. Single-role air-to-air fighter unit information is presented in a narrative style to facilitate a better understanding of each squadron's operations and the relationship of these operations to those of other units. Background is also provided on each unit and on each conflict to help further an understanding of the context in which operations were conducted. When applicable, reference is made in each narrative to data supporting the criteria for measuring air-to-air combat effectiveness discussed previously.

Interspersed in this first section is general information, primarily that of a statistical nature, on multi-role fighter units. As opposed to addressing unit-specific details, these subsections present data bearing on overall conflict or theater operations that relate to the issue of air-to-air combat effectiveness. This information is included to help place much of the unit-specific data in its proper perspective relative to the effectiveness of other combat fighter units operating at the same time or in the same places.

The second section provides information of a subjective nature. Included in this section are authoritative observations and analyses of air-to-air combat operations that bear on the subject of single-role versus multi-role fighter unit combat effectiveness. When the basis of authority is not evident, brief background information is provided to establish the credibility of those referenced. Information in this section is directly related to the criterion of "mission objective accomplishment" discussed in Chapter Two.

Objective Background Information

American Volunteer Group In China In World War II

The American Volunteer Group (AVG) is the only World War II fighter unit I have included in this thesis. The Flying Tigers of the AVG are unique in that theirs were

arguably the only squadrons in World War II intended from the outset to be air-to-air fighter forces. Although near the end of its existence the AVG conducted limited dive bomb operations, this unit remained an air-to-air force.¹ Therefore, the AVG is considered here as one of the very few dedicated single-role air-to-air fighter units.

The day after he retired from the U.S. Army Air Corps in April, 1937, Captain Claire Chennault left for China to serve as the chief air advisor to the Chinese Air Force.² When war erupted three months later between China and Japan, Chennault took charge of the combat training of Chinese fighter and bomber squadrons. By the fall of 1938, the Chinese Air Force had been so decimated that Madame Chiang approached Chennault and asked him to form a flying foreign legion to defend China.³ From this seed grew the Flying Tigers of the AVG.

Chennault was eventually able to obtain from the U.S. government a commitment to send China 100 P-40 Warhawk fighters. He then began recruiting sufficient numbers of ex-military pilots to man the three squadrons he was forming. When General Chennault requested pilots for his fledgling AVG squadrons, he asked for men in their twenties who had at least three years experience in fighters and a minimum of 300 hours flying time.⁴ Of the 110 men who originally formed the Flying Tigers, only 12 met these qualifications.⁵ Yet

Chennault took these men and turned them into some of the deadliest fighter pilots of World War II.

Almost to a man, the pilots of the AVG credited their success to the training given them by General Chennault. Each day Chennault conducted what he termed "Kindergarten," an intense ground school designed to teach the AVG pilots everything they needed to know about flying their P-40 fighters and about the Japanese threat they would face in combat.⁶ In addition, Chennault daily watched his pilots through binoculars while they practiced their dogfighting skills directly above his position in the control tower.⁷ By maintaining constant radio communications, he was able to correct errors and instruct his pilots on a real-time basis.

Chennault allowed his pilots to fly combat missions only after he was satisfied with their performance. Said Chennault: "I refused to throw a pilot into the fray until I was personally satisfied that he was properly trained."⁸ He was so intransigent about this that in March, 1942, seven months after beginning operations, Chennault still had eighteen pilots he would not allow in combat because he considered them unready.⁹ Training was clearly the key to the success of the AVG. Those who survived the rigors of General Chennault's training program felt more than ready to handle the Japanese.

The primary role of the Flying Tigers was to prevent the Japanese Air Force from effectively interdicting the port

of Rangoon and the Burma Road, which together formed the only viable supply lifeline into China.¹⁰ To this end, the Flying Tigers began combat operations in December, 1941. For the most part, AVG missions involved bomber escort on raids against various Japanese targets, fighter sweeps to seek out and destroy Japanese aircraft, and defensive CAPs at or near the AVG operating fields.

Despite the important nature of its work, or perhaps because of it, the AVG was extremely short-lived. It was dissolved in July, 1942, and replaced by a more official organization, the Army Air Corps' 23rd Fighter Group, after only eight months in existence and a mere six months of combat.¹¹ Yet during this six-month period, the Flying Tigers were credited with 297 confirmed and 150 probable kills against Japanese aircraft, with the loss of only six P-40s in air-to-air combat.¹² The resulting kill-to-loss ratio was an incredible 50:1. Further, these kills came on only 311 total engagements, yielding a kill per engagement ratio of .95.¹³

World War II - Multi-Role Fighter Units

On July 4th, 1942, the day the AVG Flying Tigers became the 23rd Fighter Group Flying Tigers, the scope of operations for this unit changed dramatically. The unique, single-role air-to-air focus quickly changed to a broad multi-role perspective.

Although the 23rd continued to fly the same bomber escort and airdrome defense missions that the AVG had flown, the group also began flying extensive dive-bombing, armed recce patrols (gun strafing), low-level skip bombing, anti-shipping attacks, and visual reconnaissance missions.¹⁴ As a clear indication of how much the mission orientation of the Flying Tigers had changed, P-40s assigned to bomber escort missions were themselves loaded with bombs so the pilots of the 23rd could carry out dive-bombing missions in the target area.¹⁵

During the three years that the 23rd flew in China during World War II, the group shot down 621 Japanese aircraft and lost 110 fighters in air-to-air combat.¹⁶ The resulting kill-to-loss ratio is 5.6:1. While nowhere near the 50:1 kill-to-loss ratio achieved by the AVG, the record of the 23rd far exceeds that of all multi-role Army Air Force units in the Pacific theater during the war. The kill-to-loss ratio of this latter group was 1.96:1, which represented 8899 enemy aircraft shot down and 4530 friendly losses in air-to-air combat.¹⁷

USAF 4th Fighter Interceptor Wing In Korea

On November 1st, 1950, six jet fighters crossed south of the Yalu River into Korea and engaged a flight of USAF P-51 Mustangs.¹⁸ Although able to escape, these Mustang pilots learned the hard way just how capable were the new Russian-made MiG-15s of the Chinese Air Force. The presence

of the MiG-15 suddenly rendered obsolete the venerable Mustang and every other U.S. and U.N. fighter in the Far East.¹⁹ Unless immediate steps could be taken to counter the MiG threat, USAF leaders knew the air superiority enjoyed by U.N. forces would soon be lost.

Following hurried requests for additional forces, General Hoyt Vandenberg, the Air Force Chief of Staff, offered to send to the Far East a wing of new F-86 Sabrejets, but only if a suitable airfield could be prepared in the combat area.²⁰ Major General Earle Partridge, 5th Air Force Commander, ordered that such preparation be made, and shortly thereafter the 4th Fighter Interceptor Wing (FIW) arrived at Johnson AFB, Japan. On December 15th, 1950, F-86s from the 4th FIW's forward detachment at Kimpo Airfield, Korea, flew their first combat missions.²¹

The 4th FIW thus became the first of two USAF wings dedicated solely to air-to-air combat in Korea. On good weather days, squadrons in the 4th flew four counterair missions, two intercept missions, two escort missions, and one combat indoctrination mission.²² Occasionally, the wing also flew search patrol and rescue air cover missions. Although they vary greatly in the mechanics of execution, all of these missions fall into the air-to-air combat category. But of them all, counterair became the trademark of the 4th FIW. These counterair missions, designed to aggressively

seek out and destroy the enemy, took a massive toll on the Chinese MiG-15 force.

Between December 15th, 1950, and July 27th, 1953, the 4th FIW flew 45,143 sorties, scored 484 air-to-air kills, and lost 48 F-86s in air-to-air combat.²³ The resulting overall kill-to-loss ratio in this first all-jet combat was an outstanding 10:1. During the war, 520 pilots flew combat missions with the 4th FIW. As in all wars, a few pilots accounted for large numbers of kills, while most pilots had few, if any, kills.

Nevertheless, statistics can be discerned to support several composite measures of effectiveness in air-to-air combat. Based on an average of 72 combat missions per pilot, the 4th FIW ended the war with a shot per engagement ratio of .45:1, a kill per engagement ratio of .21:1, and a kills per firing attempt ratio of .47:1.²⁴ These numbers include many instances in which F-86 pilots never fired a shot, but in which MiG-15 pilots lost control during maneuvering and either spun into the ground or bailed out. In these situations, the 4th FIW combat historian credited a kill to the pilot and counted a "firing" to indicate the intensity of the Sabre pilot's attack.²⁵

A great deal has been made of the tremendously lopsided ratio of MiG kills to F-86 losses, and always this amazing record is attributed not to any superiority in aircraft or equipment, but to the superior training of USAF

pilots.²⁶ As a dedicated air-to-air fighter wing, the 4th executed and trained only for those air-to-air missions required of them in Korea.

Although combat operations always took priority, the 4th FIW, like all units in Korea and Japan under the USAF's Fifth Air Force, conducted intensive training throughout the war. Every pilot in the theater had to be certified by his commander as being capable of flying combat missions before he was permitted to do so.²⁷ To support this certification, each squadron set up a training program geared to pilot proficiency. In this manner, a World War II veteran with multiple kills and thousands of hours of flying time was not required to complete the same training regimen mandated for a young lieutenant fresh out of pilot training. Instead, each pilot received the training appropriate for him as an individual.

Even after trained pilots were integrated into flights within the squadron, they were not considered combat ready pilots. Instead, each was scheduled for two or three missions of shorter duration and under less dangerous conditions than was considered the norm. These "cherry rides" were, in effect, training missions flown under actual combat conditions.²⁸ Much as was the case with the Flying Tigers, the 4th FIW trained in a superlative manner in its role as dedicated, single-role air-to-air fighter unit. This training produced pilots both highly knowledgeable of and

skilled in their craft; their results bear witness to the effectiveness of their training programs.

Korea - Multi-Role Fighter Units

As already discussed, F-86 squadrons were brought to Korea for only one reason: "to fly combat air patrol over Northwestern Korea and to meet, turn back, and, if possible, destroy MiGs."²⁹ Despite the tremendous air-to-air combat success enjoyed by the F-86 units, MiGs were still a factor with which our other multi-role fighter forces had to contend. As Table 1 shows, F-51s, F-80s, and F-84s of the USAF Far East Air Forces (FEAF) did not fare well against the MiG-15.

Table 1. Korea: Air-To-Air Combat Results³⁰

Type A/C	Kills	Probables	Damaged	Losses
F-86	447	57	511	59
F-84	8	11	83	18
F-80	6	8	32	14
F-51	0	0	9	10
RF-80	0	0	0	1
B-26	3	0	1	0
B-29	16	7	11	13
TOTALS	480	83	647	115

* 1 Nov 1950 To 31 Oct 1952

During the two-year period addressed in Table 1, these multi-role fighter forces combined for a total of only 14 confirmed kills, but sustained 42 losses. The resulting kill-to-loss ratio is a poor 1:3. Further, if one makes the best-case assumption that the "damaged" numbers accurately represent every MiG hit by a friendly fighter, then the combined "kills per firing attempt" ratio is only .10:1.

That the battle in Korea for air superiority was successful for U.S. forces is beyond question. Considering the tens of thousands of U.S. sorties flown during the war, losses to enemy fighters were negligible. By the end of the war, USAF FEAF and U.S. Marine Corps (USMC) forces had lost a total of 1986 aircraft: 945 to non-enemy causes, 816 to ground fire, 78 to unknown causes, and 147 to enemy fighters.³¹ USAF F-86 forces shot down a total of 802 MiG-15s and suffered 56 losses in air-to-air combat, resulting in an overall kill-to-loss ratio of 14.3 to 1.³²

U.S. Navy F-8 Crusader Squadrons In Vietnam

From January 1964, to January 1973, ten U.S. Navy F-8 Crusader squadrons in seven different carrier air wings made a total of 29 Vietnam cruises.³³ For these squadrons, as with virtually all others, the war in Southeast Asia was, in effect, two separate wars. From their first operations in 1964, until the beginning of the bombing halt and prohibition against flights into North Vietnamese airspace in the fall of 1968, F-8 squadrons were among the most heavily tasked with missions to the North. However, after the air war picked up tempo again in early 1972, F-8 squadrons were used in CAP roles near the fleet and on other missions generally far from MiG activity. Therefore, it is the earlier period of intense activity which is of primary concern.

In 1952, the Navy's Bureau of Aeronautics set forth the required specifications for a new fleet defense

air-to-air fighter. Chance Vought eventually won this Navy contract with their design for a state-of-the-art, supersonic, single-role air superiority fighter, "uncompromised by a multi-mission capability."³⁴ When deliveries began in December 1956, the F-8 possessed a sleek design and four 20mm cannons, followed shortly thereafter by the addition of the new AIM-9 Sidewinder air-to-air missiles.

This configuration was, however, short-lived. When the last version, the F-8E (F8U-2NE), was produced, it included hard points for up to 4000 pounds of iron bombs and for the carriage of air-to-ground missiles.³⁵ The result was that both prior to and during the war, F-8 squadrons were carrying out very effective air-to-ground training programs. For example, in a 1966 Navy bombing competition, VF-211, an F-8 squadron, outscored the three dedicated attack squadrons with which it was competing.³⁶ And when war came, all F-8 squadrons in Vietnam conducted a variety of air-to-ground and SEAD missions as well.

But as described above, the F-8 was originally designed solely as an air-to-air fighter, a fact that separated it from all others. Without exception, every other tactical aircraft flown by the U.S. in Vietnam was designed either as a relatively non-maneuverable bomber interceptor or as a multi-role fighter-bomber.³⁷ Even though air-to-ground capabilities were later added to the F-8, they took nothing away from its ability to function as a superior air-to-air

fighter. Built in an age when dogfighting was considered a thing of the past, the Crusader was a fighter pilot's dream.

As a result, pilots in F-8 squadrons knew what they had and spent the majority of their time training for air-to-air combat. While the Navy's F-4 fighter did not even mount a gun, the F-8 had four. And although few of the F-8 kills were made with the gun, "the very fact that they had those four 20-mm guns provided a peacetime training stimulus to remain proficient in air combat maneuvering."³⁸

Additionally, F-8 squadrons boasted some of the highest pilot experience levels in the Navy. Even the most junior F-8 pilots in Vietnam had 500 to 800 hours in the Crusader, while division leaders frequently had 1500 hours in the F-8.³⁹

Not surprisingly, when combat operations began, F-8 squadrons put as much emphasis as possible on air-to-air missions. For example, 72% of VF-211's total sorties in 1967 were dedicated to air-to-air missions: 61% to Combat Air Patrol and 11% to escort.⁴⁰ These missions were specifically designed to locate and kill North Vietnamese fighters. These F-8 squadrons were first and foremost air-to-air fighter units, and it is for this reason that they are considered here as single-role air-to-air fighter forces.

F-8 squadron performance in air-to-air engagements was impressive. By the end of 1967, Navy aircrews had shot down 28 North Vietnamese aircraft, 13 of which were downed by three F-8 squadrons: VF-211, VF-24, and VF-162.⁴¹ VF-211

alone accounted for seven of these kills, while the most successful F-4 squadron had only three kills.⁴² When the bombing halt came in 1968, the Navy had shot down a total of 34 MiGs. Seven F-8 Crusader squadrons accounted for 18 of these kills, or 53% of the overall Navy total.

By war's end, VF-211 had shot down one additional MiG. Therefore, F-8 squadrons accounted for 19 total MiGs destroyed with the loss of 3 F-8s, for a kill-to-loss ratio of 6.3 to 1, the most favorable for any force during the war.⁴³ Further, these F-8 squadrons boasted a kill per engagement ratio of .70:1, three times as high as that of Navy F-4 squadrons.⁴⁴

Vietnam - Multi-Role Fighter Units

The overall U.S. kill-to-loss ratio in Vietnam was 2.45:1 (Table 2). The USAF achieved 70% of the kills against North Vietnamese aircraft and sustained 80% of the losses. The USN and USMC combined accounted for the remaining 30% of enemy kills and 20% of the losses. When F-8 kills and losses are deleted from Table 2, the resulting overall kill-to-loss ratio in Vietnam is 2.3:1. Since all other U.S. fighter units in Vietnam were multi-role in nature, this kill-to-loss ratio expresses the overall multi-role fighter unit performance during the war.

The USAF kill-to-loss ratio dropped relatively significantly in 1968. Prior to this time, overall USAF

fighter experience was very high; half of all pilots had over 2000 hours of total flying time and over 500 hours in the fighter they flew in Vietnam.⁴⁶ By 1968, however, less than 30% of USAF pilots had any prior fighter experience, and all averaged only 240 hours in type.⁴⁷

Table 2. Overall Air-To-Air Combat Record In Vietnam⁴⁵

Year	MiG Kills	US A/C Shot Down	Total Kill Ratio	USAF Kills	USAF A/C Shot Down	USAF Kill Ratio	USN Kills	USN A/C Shot Down	USN Kill Ratio
1965	5	4	1.25	2	3	.67	3	1	3.0
1966	22	9	2.44	16	5	3.2	6	4	1.5
1967	69	25	2.76	55	21	2.62	14	4	3.5
1968	14	10	1.4	8	7	1.14	6	3	2.0
1969	0	0	-	0	0	-	0	0	-
1970	1	0	-	0	0	-	1	0	-
1971	0	1	-	0	1	-	0	0	-
1972	71	26	2.73	47	23	2.04	23	2	11.5
1973	2	0	-	1	0	-	1	0	-
TOTAL	184	75	2.45	129	60	2.15	54*	14*	3.86

* Does not include USMC, which shot down 1 MiG and lost one fighter in 1972.

The tremendous improvement in the U.S. Navy kill-to-loss ratio after combat operations in North Vietnam began again in 1972, is largely attributable to the presence of USN Top Gun graduates in each of the squadrons. This small group of highly trained pilots accounted for 50% of all kills made by the Navy in Vietnam after the Top Gun course began in late 1968.⁴⁸

As the war continued, more and more F-4 Phantom squadrons entered the conflict and assumed the majority of the air-to-air mission tasking. Although certain flights

within certain squadrons were dedicated for short periods of time exclusively to air-to-air operations, these squadrons remained multi-role in nature. Large numbers of assets and favorable tasking resulted in these squadrons accounting for the bulk of the North Vietnamese air-to-air combat losses (Table 3). Also, as discussed previously, the F-8 squadrons saw air-to-air action only up through 1968, while the F-4 and F-105 squadrons continued operations until the end of the war.

Table 3. Air-To-Air Kills In Vietnam By Aircraft Type⁴⁹

TYPE A/C	USAF	USN/USMC	TOTAL	%
F-4	104	33	137	74
F-105	23	-	23	13
F-8	-	19	19	10
A-1	-	2	2	1
A-4	-	2	2	1
B-52	2	-	2	1
TOTALS	129	56	185	100%

Israeli Mirage Squadron In The 1967 Arab-Israeli War

Prior to the summer of 1967, Israel had stated that it would go to war if any of the following were to occur: closing of the Strait of Tiran; sending of Iraqi troops to Jordan; signing of an Egyptian-Jordanian defense pact; or withdrawal of United Nations Emergency Force (UNEF) forces.⁵⁰ By May 31st, 1967, all of these actions had taken place, and the Israelis had decided that war was inevitable. They therefore decided to launch a preemptive attack against Arab forces. On June 5th, the Israeli Air Force (IAF) spearheaded

this effort, attacking and destroying the bulk of the Egyptian, Jordanian, and Syrian air forces by the end of the first day of combat.⁵¹

During the Six-Day War, one of the key air assets employed by the Israelis was the French-made Dassault Mirage 3C fighter. Although designed primarily as an air superiority interceptor, the Israeli Mirages also saw action during the war in air-to-ground roles, which included strafing, dive-bombing, and SEAD. Air-to-air operations took the form of top cover for attacking fighter-bombers and air defense of major Israeli cities and bases.⁵² Yet one of these squadrons amassed the highest number of air-to-air kills of any Israeli squadron, scoring 20 confirmed and 3 probables against Arab fighters and fighter-bombers.⁵³ Sustaining no air-to-air losses, this squadron achieved a kill-to-loss ratio of 20:0. While this squadron at first appears to have been a multi-role unit, the following will explain why it is treated as a dedicated air-to-air squadron in this thesis.

In the fall of 1966, a defecting Iraqi Air Force pilot flew his Soviet-made MiG-21C to Israel. Although the MiG-21 was the same aircraft being flown by the North Vietnamese against U.S. forces in Southeast Asia, it had not yet been flown in combat by Arab forces in the Middle East. Therefore, the Israelis used this opportunity to learn everything they could about the MiG-21. First, the Israelis

assigned their top pilots to fly the aircraft and evaluate its performance against their best air-to-air fighter, the Mirage 3C. Surprisingly, the consensus among these pilots was that the MiG-21 was just as good as the Mirage in overall performance.⁵⁴

To share this new knowledge, the Israeli pilots who had checked out in the MiG-21 began flying missions against pilots from the Mirage squadrons. During these mock combat sorties, the Israeli Mirage pilots were able to see first-hand their primary air threat and to learn how to defeat it. Each mission was followed by an intense debriefing session to help bring out lessons learned, which were then incorporated into the squadrons' individual tactics manuals. For the Mirage pilots, already well-versed in the air-to-air business, this program made them more than ready for aerial combat with the Arab air forces when the war began.

This preparation proved of immense importance because the first day orders from IAF headquarters to all fighter units expressly forbade air combat on offensive missions, excluding top cover missions, unless a flight was intercepted in the course of attacking an airfield. Putting bombs on target was the absolute first priority. As one of the senior squadron pilots noted, the result was that the Israeli pilots "never knew ahead of time if MiGs were around. They were all accidental meetings. Sometimes we took them from behind, sometimes they came at us from behind."⁵⁵

This is significant because it points out that the kills this squadron made were not the result of carefully pre-planned and orchestrated traps laid for unknowing bandits. Rather, each flight simply took the engagement as it occurred and maneuvered as best it could. Nevertheless and without exception, every time a squadron pilot engaged in an air-to-air dogfight, at least one MiG was shot down.⁵⁶ Although specific numbers are not available, this statement points to a kill per engagement ratio of greater than 1.0:1, an achievement impressive by any standard.

When interviewed shortly after the end of the Arab-Israeli Six-Day War, Israeli Air Force officials gave credit to the intensive specialized training in the MiG-21 for the overwhelming success of their operations.⁵⁷ This belief was echoed at the squadron level as well. As one Mirage pilot later reported, this intensive training gave him "the satisfaction of seeing young pilots fighting like senior pilots."⁵⁸ Clearly, the impressive Israeli aerial combat results for this Mirage squadron were due to the emphasis put on gaining and maintaining a very high level of proficiency in air-to-air combat.

Six-Day War - Multi-Role Fighter Units

The Israeli Mirage squadrons were the only fighter units assigned specific air-to-air missions during the war. All other Israeli fighter squadrons were tasked in ground attack roles and engaged in air-to-air combat only as a means

of self-defense. For this reason, the vast majority of all air-to-air kills in the war belong to the Mirage squadrons.

However, one of the difficulties associated with an analysis of the Six-Day War is the extent of conflicting claims between the Israelis and the Arab states. For example, the Israelis claim that all their Mirages shot down 50 Egyptian MiGs in 64 engagements and suffered not a single loss; the Arabs claim to have shot down 161 Israeli aircraft for the loss of only 2 Egyptian fighters.⁵⁹ While Arab claims such as these are clearly false, reliable reporting immediately after the war indicates that at least 5 Israeli Mirages were shot down during the first two days of the war.⁶⁰

An associated difficulty is the claimed cause of a particular aircraft loss. For example, the Israelis acknowledge that they lost a total of 26 aircraft to enemy surface-to-air weapons and enemy fighters.⁶¹ However, the Israelis are vague at best as to the specific numbers of aircraft lost to each cause. The Egyptians have long contended that the Israelis have lied about their combat losses by claiming that many aircraft actually shot down in air-to-air engagements were shot down by SAMs or AAA instead. The Egyptians believe this to be a face-saving effort on the part of the Israelis; it is far easier to admit being defeated by a sophisticated weapon of war than by a superior human foe in another fighter.

Although the truth will probably never be known, the problem of determining relative combat effectiveness remains. All that can be said with certainty of the Israeli multi-role squadrons, primarily those with Sud Aviacion Vautours and Dassault Mystere IVAs, is that they did achieve some unknown number of air-to-air kills during the war.⁶² Combat narratives make clear that any air-to-air combat these units engaged in was done for defensive purposes while ingressing or egressing from a target area. Unlike Mirage flights flying escort or top cover missions, at no time did these units have the opportunity to initiate an engagement. They simply reacted to the threat and took whatever shots of opportunity presented themselves.

British Sea Harrier Squadrons In The Falkland Islands War

On April 2nd, 1982, a 2000-man Argentinean task force invaded the British-governed Falkland Islands. Three days later, the British Royal Navy dispatched two light aircraft carriers and 28 other ships to retake the Falklands.⁶³ Onboard HMS Hermes and HMS Invincible were No. 800 Squadron and No. 801 Squadron respectively, the two Sea Harrier squadrons that would make every British air-to-air kill during the coming air battle with Argentinean air forces.

The Sea Harrier FRS.1 is a short takeoff, vertical landing, single-seat naval fighter designed primarily for reconnaissance and anti-ship strike operations. This

aircraft had proven so versatile, however, that at the time of the war in the Falklands, No. 800 and No. 801 Squadrons were also employing the Sea Harrier in ground attack, SEAD, escort, and CAP roles.⁶⁴ However, in a manner similar to that of the Israeli Mirage squadrons, these seemingly multi-role units are considered here as single-role units dedicated to air-to-air combat because they performed almost exclusively in this role during the conflict.

During the air war, which lasted from May 1st until June 13th, the Argentinean Air Force flew 445 combat missions involving a wide variety of fighters and fighter-bombers.⁶⁵ The vast majority of these were attack missions designed to penetrate British defenses and sink or destroy ships of the naval task force. To counter Argentinean air attacks, the British relied heavily on their Sea Harriers, of which no more than 25 were available at any one time.⁶⁶ While not the only mission flown by them, both No. 800 and No. 801 Squadrons dedicated the vast majority of their efforts to CAP missions to defend the fleet.

But with the exception of operations on May 1st, the first day of the air war, the Argentines never engaged the British in fighter-versus-fighter combat.⁶⁷ On that day, the Argentines lost two Mirage IIIs, their premier air-to-air fighters tasked with escorting the fighter-bombers. Not wishing to chance losing more, the Argentines thereafter

kept the Mirages at home. As a result, British Sea Harriers were unopposed for the rest of the war.

Not only were the penetrating Argentinean fighter-bombers unescorted and, therefore, unprotected from Sea Harrier attack, but they were also forced to fly very predictable low-level routes to avoid ship-based SAMs and guns. What developed was a continuing situation in which the Sea Harrier pilots simply waited high above the task force for ingressing Argentinean fighter-bombers to approach and then dropped down unobserved while the Argentineans were preoccupied with their attacks.

Armed with only two AIM-9L air-to-air missiles and two 30mm gun pods, No. 800 and No. 801 Squadrons maintained Sea Harriers continuously on station high above and in front of the task force. These flights committed against enemy aircraft based on either visual contact or on information provided by ship borne radar. But in all cases, they were required to maneuver to within visual range of enemy aircraft to engage with the infrared-homing AIM-9L or with the gun.

By the end of the air portion of the war on the 13th of June, Sea Harriers had shot down a total of 23 Argentinean aircraft. And although the two Sea Harrier squadrons lost six aircraft during the war, none were lost in air-to-air combat.⁶⁸ Of the 23 British air-to-air kills, 18 were made with AIM-9Ls, 3 with the 30mm gun, and one with an AIM-9L/gun combination.⁶⁹ The remaining kill was on a Puma helicopter

that flew into the ground while trying to escape a Sea Harrier attack.⁷⁰

The No. 800 and No. 801 Squadrons achieved their 18.5 AIM-9L kills in 23 engagements, resulting in a kill per engagement ratio of .80:1.⁷¹ Further, squadron pilots took a total of 25 AIM-9L shots. Of these 25 shots, 23 were valid, and 2 were invalid for excessive range at launch.⁷² These figures yield a shot per engagement ratio of 1.13:1, a hit per firing attempt ratio of .73:1, and a kills per firing attempt ratio of .71:1.

After the war, Argentinean military personnel were interviewed by a variety of people seeking to produce a history of the war. In addition to confirming all 23 of the British air-to-air kills, Argentine Air Force pilots repeatedly commented about the Sea Harrier and AIM-9L missile combination. One Argentinean A-4 pilot who survived the war commented:

Those pilots lost to Sea Harriers never saw the missiles being fired, though some of the other pilots [in the flight] did. There was generally no time to respond to a Sidewinder shot; [even] if the pilot saw it, it was too late.⁷³

A No. 8 Squadron pilot interviewed after the war attributed his success to superior peacetime training:

In the Royal Air Force we train as hard as any air force I know. We try to make things as realistic as possible. We really go for it, we probably hurt ourselves more in training than we would be hurt in war.⁷⁴

Without question, this rigorous training was a significant contributor to these squadrons' success in the Falklands. But the Sea Harrier squadrons also benefited by operating in an environment made to order for them. Unopposed by enemy fighters, they flew against vulnerable fighter-bombers forced into predictable routes and flown by pilots who virtually never saw their attackers in time to survive. For these reasons, a comparison of British experiences in the Falklands with those of the other units addressed must take this factor into account.

Subjective Background Information

General

The issue of fighter specialization did not materialize in the United States in any meaningful way until the early 1960s. At the beginning of the Kennedy administration, Secretary of Defense McNamara codified a new U.S. military strategy that moved away from sole reliance on nuclear weapons and more toward the use of conventional forces.⁷⁵ This strategy greatly increased the importance of general purpose forces and particularly that of fighter aircraft. The method of employing these forces in the overall scheme of national defense thus became the focus of much debate.

Favoring Multi-Role Fighter Units

Up until this time, the traditional Air Force view had been that fighter aircraft should be inherently multi-role in nature. Major General William Momyer, Air Force director of operational requirements, was typical of those senior officers who argued that multi-role fighters had been effective in World War II, Korea, and Vietnam, and that any justification for specialization "must be on the basis that it can perform the job more effectively than an aircraft that can do multimissions."⁷⁶ Of this, he was not convinced.

General Momyer was one of the Air Force's most enthusiastic supporters of Secretary McNamara's concept for the TFX fighter, which eventually became the F-111 aircraft. In justifying his belief in this program, General Momyer said:

When you consider that within this tactical fighter we will be doing all the jobs that in World War II we did with B-17s, B-24s, B-26s, P-51s, and P-47s and you look at this machine in terms of this kind of flexibility, I think the state-of-the-art has come a long way in enhancing our tactical ability.⁷⁷

It is difficult to imagine a more ringing endorsement of multi-role fighter capabilities.

Other officers favored multi-role fighters and units not on the basis of effectiveness, but on tactical need. This group argued that the most efficient way to destroy enemy airpower was to destroy the enemy's aircraft on the ground. Because of this, they believed that fighter forces dedicated only to air-to-air combat were a waste of

resources. This position was officially endorsed in 1965, by General Walter Sweeney, Jr., the commander of TAC, and the officers of his Tactical Fighter Tactics and Weapons System Panel.⁷⁸

Favoring Single-Role Air-to-Air Fighter Units

In August, 1965, less than a month after General Sweeney argued the case for multi-role fighters and units, he was succeeded as the commander of TAC by General Gabriel Disoway. As discussed in Chapter One, General Disoway was very much the opposite of his predecessor in terms of his views on multi-role aircraft. In February, 1966, he and the commanders of Pacific Air Forces (PACAF) and United States Air Forces in Europe (USAFE) made a joint recommendation to the Air Force chief of staff, General John McConnell, concerning the USAF's next fighter development effort. A portion of their recommendation was that the F-X fighter:

must be optimized for the air-to-air role [and] that any attempt to configure the F-X for an air-to-ground mission will result in a second best aircraft, incapable of competing with modern hostile aircraft in aerial combat.⁷⁹

General McConnell, while acknowledging the fact that differing views existed in the Air Force over what the F-X aircraft should be, nevertheless strongly endorsed the recommendation of the Air Force's three senior tactical leaders. His insistence that future air-to-air forces not be degraded with other missions resulted in the single-role F-15C air-to-air fighter forces that are still flying today.

Another endorsement of single-role fighter units came in 1971, from a very unlikely source: General Momyer. As has been noted, General Momyer had been a strong advocate for multi-role fighter aircraft and units. But having witnessed the myriad problems of U.S. air forces in Vietnam, and now concerned with a potentially much more intense war in Europe, General Momyer changed his beliefs on this issue. As the commander of TAC, he stated that the U.S. and our NATO allies must be:

able to aggressively pursue air operations involving concurrent air superiority, counterair, interdiction, and close air support if deterrence fails....In short, we will not be afforded the luxury of accomplishing tactical air missions one at a time if deterrence fails and we are thrust into a conventional war in Europe.⁸⁰

The general concluded by saying that this situation necessitated a large number of specialized fighter forces, all of which could be employed simultaneously in their areas of concentration in order to win the air war.⁸¹

In 1975, Secretary of Defense James Schlesinger introduced the concept of the high-low weapons system mix throughout the DOD. His idea was to use cost as the deciding factor in providing the services with the proper combination of sophistication and quantity. General David Jones, the Air Force chief of staff, embraced this concept as a way to further support his desire for specialized fighters:

The high-low mix and mission optimization go hand in hand. The planned mix of USAF tactical fighters emphasizes aircraft performance in specific mission areas. This mission optimization enhances

proficiency and performance in each area while retaining inherent capabilities in the others.⁸²

The F-15, optimized for air-to-air combat and fully supported by General Jones, had recently entered the USAF inventory and fit very nicely into the high end of the fighter force mix.

But even before this, weapons and tactics officers and fighter squadron commanders at the 1972 Tactical Fighter Symposium had concluded that USAF fighter forces needed to be optimized. These tactical leaders recognized the inability of multi-role units to do all things well. Therefore,

Optimized training was to be based on reducing the number of roles required in multipurpose tactical aircraft. Aircrews would concentrate primarily on either the air-to-air or air-to-surface role, but not on both. They would maintain a secondary but less-demanding capability in the other role.⁸³

This concept was soon thereafter adopted by the Air Force in all multi-role squadrons. While not an argument for dedicated air-to-air fighter forces, these fighter experts clearly acknowledged that multi-role units could only be proficient in air-to-air combat if they placed their training emphasis on this role.

Major Robert Heston, one of the first pilots to fly operationally in the F-15, noted that this air-to-air emphasis had historically been lacking in the U.S. military. Heston pointed out that in every war in this century in which the U.S. had fought, the need for aircraft and crews specializing in air-to-air combat had not been recognized until after the conflict had begun.⁸⁴ And unfortunately,

although this need was eventually acknowledged, the forces required to carry out air-to-air tasking were too often made to do so with "ill-suited aircraft and training."⁸⁵

In the F-15 Eagle, the USAF had for the first time anticipated in peacetime the need for forces dedicated to and proficient in air-to-air combat. At the same time, the Navy had also recognized this need and developed the F-14 Tomcat for the fleet defense role. F-14 squadrons were deployed aboard aircraft carriers and dedicated solely to those air-to-air combat missions that supported USN operations. By the mid-1970s, specialized air-to-air fighter forces had become the accepted norm in both services.

Nor was the military alone in its belief in air-to-air fighter specialization. Congress had become enamored with the need for a true "dogfighter" and consequently took an active role in this area. In October 1974, the Senate released a statement saying that intelligence analyses of enemy capabilities made clear that any future wars in Europe or the Middle East would require superior dogfighting capabilities on the part of U.S. fighter forces.⁸⁶ At the time, some members of Congress, although pleased with the Air Force's F-15 program, were concerned that the Navy's F-14 might not be as capable in air-to-air combat because it was not specialized enough. Clearly, dedicated air-to-air fighter forces were perceived as necessary to support U.S. national security objectives.

Until very recently, this view continued to be the basis for relevant fighter force structuring in the U.S. In 1991, General McPeak testified before Congress that he desired five and a half wings (650 fighters) worth of "air-to-air dedicated aircraft" in the base force that was then proposed.⁸⁷ These forces would be comprised of the F-15s now in the inventory and the F-22s programmed to replace them. General McPeak further indicated that if the base force decreased in size, as it now has, this would not eliminate the need for dedicated air-to-air fighter forces. Rather, the number would simply decrease to maintain the same ratio of air-to-air fighters to all fighters as originally proposed.

When questioned on how he could possibly justify the Air Force request for so many new, highly-sophisticated, stealthy F-22 air-to-air fighters in light of the reduced global military threat, General McPeak responded:

We are militarily strong and therefore there is no threat out there. If you want to produce the threat, work our way back into military weakness, then the threats will reappear. So I make no apologies for the size of this force and the fact that it represents military strength in the air probably greater than we would need to face any logical regional opponent. Remember, we are not interested in a long, hard fight in which at the end we are flying the only surviving airplane and the other guy is down to zero. We want to achieve quick, decisive military results with a low loss rate on our side ... we are trying to configure a force which will produce decisive results at the lowest affordable cost.⁸⁸

Despite current USAF initiatives moving away from specialized fighter forces, the military's desire for them has not changed. What has changed is our ability to pay for fighter forces dedicated to a single role. The reasons General McPeak gave in 1991 for these forces are arguably even more relevant today given the unstable global military situation. While many senior officers have come forth in support of multi-mission fighter forces, they have not claimed that these forces are more effective than those dedicated to air-to-air combat. Rather, the dictates of a shrinking defense budget have simply come to overshadow many of the concerns addressed in this thesis.

CHAPTER 4

ANALYSIS

Introduction

The purpose of this chapter is to analyze the historical information presented in Chapter Three relative to the measures of effectiveness developed in Chapter Two. The basic methodology is to review and analyze the data on all units for one measure of effectiveness at a time. Each of these analyses yield one of four possible conclusions: single-role air-to-air fighter units are the most combat effective; multi-role fighter units are the most combat effective; both single-role and multi-role fighter units are equally combat effective; or insufficient data is available to determine relative combat effectiveness.

Empirical data on each of the objective measures is evaluated first, followed by one composite analysis of all the objective measures. The evaluations of each of these measures are based both on the empirical data itself and on the subjective interpretation I bring to the issue based on my research and experiences.

A single subjective analysis of air-to-air combat effectiveness is then made based on all of the authoritative commentary presented in Chapter Three. Finally, the results

of the objective and subjective analyses are then compared with one another to make a final determination on whether single-role or multi-role fighter units are the most effective in conducting air-to-air combat operations.

Kill-to-Loss Ratio

My research for this thesis clearly indicates that "kill-to-loss ratio" is the most common measure used to evaluate air-to-air combat effectiveness. Even in those combat narratives and studies that contain little empirical data describing the outcome of a conflict, kill-to-loss ratios can always be found. At a minimum, all post-mission debriefings include kills and losses; therefore, determining kill-to-loss ratios is a relatively simple process.

I have also found that all parties to all conflicts agree with the definitions of "kill" and "loss" presented in Chapter Two. This agreement makes this measure an especially appropriate one for direct comparison of various fighter units. Finally, all combatants are in general agreement that kill-to-loss ratios are the true bottom line and accurately reflect their combat effectiveness when measured over an extended period of time.

Kill-to-loss ratios for all of the fighter forces addressed in Chapter Three are presented in Table 4. These ratios vary between 50:1 and 6.3:1 for the single-role air-to-air fighter forces, and between 5.6:1 and 1:3 for the multi-role forces. Disregarding for the moment the

particular conflicts involved, these numbers show that the lowest kill-to-loss ratio for a single-role unit, 6.3:1, is still higher than that of the best of the multi-role forces, 5.6:1.

Table 4. Kill-To-Loss Ratios

UNIT	TYPE UNIT (Single-role or Multi-role)	KILL-TO-LOSS RATIO
AVG FLYING TIGERS	SINGLE	50:1
4TH FIW F-86 SQUADRONS	SINGLE	10:1
USN F-8 SQUADRONS	SINGLE	6.3:1
ISRAELI MIRAGE SQUADRONS	SINGLE	20:0
BRITISH HARRIER SQUADRONS	SINGLE	23:0
23RD FIGHTER GROUP	MULTI	5.6:1
MULTI-ROLE UNITS - PACIFIC	MULTI	1.96:1
MULTI-ROLE UNITS - KOREA	MULTI	1:3
MULTI-ROLE UNITS - VIETNAM	MULTI	2.3:1

Further, the only forces to experience more losses than kills (i.e., a 1:3 kill-to-loss ratio) were the multi-role forces in Korea. The consistently higher kill-to-loss ratios of the single-role fighter forces point to a generally higher level of combat effectiveness than that of the multi-role forces.

But a comparison of kill-to-loss ratios within a conflict or theater is perhaps most relevant. For example,

the Flying Tigers were 25 times more effective than multi-role forces in the Pacific (50:1 versus 1.96:1). Similarly, the 4th FIW was 30 times as effective as the multi-role forces in Korea (10:1 versus 1:3). And even the Navy's F-8 squadrons, which only operated for roughly half of the war, were still 3 times as effective as the multi-role forces in Vietnam (6.3:1 versus 2.3:1). The comparisons were even more lopsided in the 1967 War, in which the Mirages had almost all kills, and in the Falklands, in which the Harriers had all kills.

The case of the 23rd Fighter Group is particularly illustrative because it bridges the gap between the single-role nature of the AVG and the purely multi-role nature of other fighter units in the Pacific. When the AVG transitioned to the 23rd Fighter Group in July of 1942, a number of the former AVG pilots stayed on and brought with them their experience and enthusiasm for air-to-air combat.¹ Also, an additional cadre of former AVG pilots remained for a short time to train the "green" 23rd pilots in the art of air-to-air combat.²

Therefore, although the 23rd rapidly became a true multi-role fighter force, the nucleus of former AVG pilots helped the group maintain some semblance of air-to-air emphasis. However, this emphasis was offset not only by the multi-role tasking of the 23rd, but also by the continuous loss of experienced pilots on other missions. For example,

during the same period in which the 23rd lost 110 aircraft in air-to-air combat, the group also lost 90 aircraft to enemy AAA during ground attack missions.³ These factors help explain the 23rd's 5.6:1 kill-to-loss ratio, which, while far from that of the AVG, was still much better than that of the remainder of the multi-role fighter forces in the Pacific.

In summary, single-role fighter forces consistently achieved higher kill-to-loss ratios than did multi-role forces. These higher ratios are particularly evident when comparing single-role and multi-role forces within the same conflict. These comparisons of kill-to-loss ratios clearly indicate that single-role air-to-air fighter forces are more effective than multi-role fighter forces in conducting air-to-air combat.

Kills Per Engagement

Measuring kills per engagement is useful because it helps eliminate the opportunity factor inherent in measuring kills alone. For example, the 50:1 kill-to-loss ratio of the AVG Flying Tigers appears initially to have made the AVG much more effective than Navy F-8 squadrons in Vietnam, which had a 6.3:1 kill-to-loss ratio. But the AVG had 311 total engagements, while the F-8 squadrons only had 27 engagements. The resulting kill per engagement ratios of the AVG and the F-8 squadrons, .95:1 and .70:1 respectively, therefore indicate similarly effective performance for both of these fighter forces.

The kill per engagement ratios of the fighter forces are listed in Table 5. Data are not available for the 23rd Fighter Group and the multi-role fighter forces operating in the Pacific theater during World War II. Also, as will be discussed in further detail, the "low" ratio for multi-role fighter forces in Korea is a deduction based on other empirical data.

Table 5. Kills Per Engagement

UNIT	TYPE UNIT (Single-role or Multi-role)	KILLS PER ENGAGEMENT
AVG FLYING TIGERS	SINGLE	.95:1
4TH FIW F-86 SQUADRONS	SINGLE	.21:1
USN F-8 SQUADRONS	SINGLE	.70:1
ISRAELI MIRAGE SQUADRONS	SINGLE	≥1.0:1
BRITISH HARRIER SQUADRONS	SINGLE	.80:1
23RD FIGHTER GROUP	MULTI	UNKNOWN
MULTI-ROLE UNITS - PACIFIC	MULTI	UNKNOWN
MULTI-ROLE UNITS - KOREA	MULTI	LOW
MULTI-ROLE UNITS - VIETNAM	MULTI	.20:1

With the exception of the 4th FIW in Korea, the kill per engagement ratios of the single-role fighter forces are all very high, varying between .70:1 and greater than 1.0:1. These numbers indicate that on at least 70% of their engagements, these fighter forces scored a kill on enemy

aircraft. In the case of the Israeli Mirage squadrons, these forces scored, on average, more than a single kill on every engagement.

The .21:1 kill per engagement ratio for the 4th FIW is very low relative to the others because of the way in which engagement was defined by the F-86 squadrons. Instead of using the definition discussed in Chapter Two, the 4th FIW considered an engagement to have taken place whenever a MiG was sighted. Therefore, literally thousands of engagements took place during which the MiGs never reacted to the F-86s, but simply departed with no shots taken by anyone involved. Because of this quite different definition, the kill per engagement ratio of the 4th FIW is not really valid for comparison purposes.

The kill per engagement ratio of slightly less than .20:1 for multi-role units in Vietnam is based on their achieving 166 kills in approximately 830 engagements. This low figure is to be expected given that most of the engagements began defensively and, thus, centered more on an attempt to survive than on an attempt to achieve a kill.

Although no hard data is available for the multi-role forces in Korea, I have concluded that their kill per engagement ratio was low based on other indicators of their performance. Because these forces lost three of their own fighters for every enemy aircraft shot down and because they shot down an enemy fighter on only 6% of their attempts, it

is reasonable to conclude that they achieved relatively few kills per engagement.

Overall, this analysis indicates that single-role air-to-air fighter forces have consistently achieved high kill per engagement ratios and, thus, have successfully defeated enemy aircraft in the vast majority of their engagements. Conversely, the available data on and a subjective assessment of multi-role forces indicates that they have achieved few kills per engagement. Based on this measure, single-role fighter forces are most effective in air-to-air combat operations.

Percentage of Engagements Survived

This measure is concerned exclusively with the defensive aspect of air-to-air combat. The ability to survive an engagement to return and fight another day is critical to the long-term success of any fighter force. While unable to clearly distinguish between various engagement beginning and ending conditions, this measure helps indicate how well a particular fighter force is able to sustain itself over time. The "percentage of engagements survived" data is shown in Table 6.

All the single-role fighter forces were quite successful at surviving engagements with enemy aircraft, achieving survival rates of 89% to 100%. Equally effective were the multi-role fighter forces in Vietnam, which survived 91% of their engagements.

Table 6. Percentage Of Engagements Survived

UNIT	TYPE UNIT (Single-role or Multi-role)	PERCENTAGE OF ENGAGEMENTS SURVIVED
AVG FLYING TIGERS	SINGLE	98%
4TH FIW F-86 SQUADRONS	SINGLE	99%
USN F-8 SQUADRONS	SINGLE	89%
ISRAELI MIRAGE SQUADRONS	SINGLE	100%
BRITISH HARRIER SQUADRONS	SINGLE	100%
23RD FIGHTER GROUP	MULTI	HIGH
MULTI-ROLE UNITS - PACIFIC	MULTI	LOW
MULTI-ROLE UNITS - KOREA	MULTI	HIGH
MULTI-ROLE UNITS - VIETNAM	MULTI	91%

Survival rates are not available for the other multi-role forces because data is scarce on the total number of engagements that took place in each conflict. While we generally have information on the number of engagements during which kills were achieved, such is not the case for the number of engagements during which the losses were sustained. Nevertheless, some deductions can be made.

Given the tens of thousands of sorties flown by multi-role forces in Korea, and the relatively few losses sustained, it is reasonable to conclude that these multi-role forces also achieved similarly high survival rates.

For the multi-role forces in the Pacific in World War II, however, the 4530 losses sustained would have required over 45,000 separate engagements to yield a survival rate commensurate with the other forces included here. It is highly doubtful that this extreme number of engagements took place; therefore, the survival rate among multi-role forces in the Pacific can be concluded to have been much lower than that for the other forces.

Finally, narrative accounts of 23rd Fighter Group missions indicate that very large numbers of engagements took place. The particularly large numbers of Japanese aircraft encountered on most missions generally guaranteed that each 23rd pilot would find himself in several engagements on each mission. The large number of engagements and the relatively few losses sustained indicate that the percent of engagements survived by the 23rd Fighter Group was high.

The data available and the additional conclusions drawn show that the percentage of engagements survived has generally been equally high for both single-role and multi-role fighter forces. No trend emerges to favor one force over another based on this criterion alone. Therefore, this measure indicates that single-role and multi-role forces are equally effective.

First Shot Opportunity

This measure is one of offensive potential during an air-to-air engagement. Because it evaluates which of two

opposing pilots or crews is the first to enter a valid weapons envelope, it makes a strong statement as to who has the greater opportunity to score a kill. But while this measure has been used successfully in academic studies, combat units have never directly recorded such information about their operations.

Therefore, to support this measure I have read a significant number of combat narratives from all of the units involved. Each tells in varying ways how engagements began in terms of the relative positioning of the combatants and who was first able to press in for a shot. By analyzing these narratives in total, I have been able to develop an overall picture of how these units conducted their engagements. While not able to detail every combat action, I can make definitive statements about whether a force generally did or did not achieve the first shot opportunity. These are represented in Table 7.

In the case of the Flying Tigers of the AVG, in almost every instance these forces were able to achieve the first shot opportunity. On defensive missions, the Flying Tigers knew which targets were most likely to be attacked by the Japanese. Therefore, they were able to position themselves in advantageous locations and at optimum altitudes from which to begin their engagements. On offensive escort or sweep missions, these forces invariably saw the Japanese defenders before they themselves were seen and so took the

fight to the enemy. It was extremely rare for the Flying Tigers of the AVG to be surprised by the Japanese.

Table 7. First Shot Opportunity

UNIT	TYPE UNIT (Single-role or Multi-role)	FIRST SHOT OPPORTUNITY (Yes/No)
AVG FLYING TIGERS	SINGLE	YES
4TH FIW F-86 SQUADRONS	SINGLE	YES
USN F-8 SQUADRONS	SINGLE	YES
ISRAELI MIRAGE SQUADRONS	SINGLE	YES
BRITISH HARRIER SQUADRONS	SINGLE	YES
23RD FIGHTER GROUP	MULTI	YES
MULTI-ROLE UNITS - PACIFIC	MULTI	NO
MULTI-ROLE UNITS - KOREA	MULTI	NO
MULTI-ROLE UNITS - VIETNAM	MULTI	NO

On air-to-air missions, the 23rd Fighter Group performed in much the same manner as the AVG had and was equally successful in gaining the first shot opportunity. However, on surface attack missions, pilots of the 23rd were often first attacked by defending Japanese fighters. But even on these missions, they were generally careful to look for enemy fighters and at times could get in the first shot. On balance, the 23rd Fighter Group more often than not achieved the first shot opportunity.

Accounts of the numerous multi-role forces in the Pacific theater are as varied as one would imagine them to be. First shot opportunities were ample on both sides. But a great many accounts relate situations in which USAF pilots ended up scoring a kill or surviving an engagement that they began defensively. This was particularly true during the latter stages of the Pacific campaign, when superior American piloting skills and experience took such a heavy toll on poorly trained and inexperienced Japanese pilots. Overall, combat narratives indicate that these forces did not enjoy a first shot opportunity the majority of the time.

4th FIW F-86 forces in Korea almost always enjoyed the first shot opportunity. During the war, the U.S. listening system, the "Y System," routinely monitored the radio traffic of the Russian ground controllers in China.⁴ As a result, American pilots knew when the MiGs were launching. Also, because the enemy usually flew in very large formations, unlike our own forces, the MiGs were easy to locate and attack.⁵ The F-86 pilots were thus able to routinely get into position high above the MiG flights and engage the enemy when they headed south across the Yalu River.

Multi-role fighter force experiences in Korea were such that the vast majority of their missions involved some type of ground attack. Therefore, the attention and focus of these units was not on countering an air threat, but on

putting ordnance on the target. For this reason, the vast majority of engagements with MiGs began defensively, and most ended with friendly losses. These forces most often did not achieve a first shot opportunity on the enemy.

Most of the Navy F-8 engagements began from an offensive or neutral position. Ship-based early warning radar, ground controlled intercept (GCI), or command and control were almost always successful in providing at least some information to the F-8 flights on the whereabouts of the MiGs. Even in those engagements begun from a neutral position, the F-8 forces usually succeeded in gaining the offensive and taking the first shot. Therefore, these forces enjoyed overwhelming first shot opportunities.

Multi-role fighter forces in Vietnam fared poorly in regard to first shot opportunity. Those on air-to-air escort missions were hampered by restrictive visual identification (VID) criteria and poor GCI coverage over parts of North Vietnam.⁶ As a result, enemy MiGs were often able to engage a strike package and take shots on the ground attack fighters before they could be engaged. In fact, 80% of all U.S. aircraft shot down in air-to-air combat fell to unseen MiGs.⁷ These forces definitely did not enjoy many first shot opportunities.

As discussed in Chapter Three, the Israeli Mirage squadrons were given orders on the first day of the 1967 War to turn to engage only if threatened by enemy aircraft. But

this is not the same as ordering one to only engage after being shot at. On the contrary, Israeli accounts indicate that these pilots liberally interpreted the word "threatened" and engaged Arab aircraft well before they were fired upon. Although not beginning these engagements from an offensive position, the Israelis did in fact usually achieve the first shot opportunity.

Finally, the British Harrier squadrons in the Falklands War gained the first shot opportunity on all but one engagement with Argentinean Mirages on the first day. As recounted earlier, Argentinean pilots attempting to engage the British fleet never took a shot on the Sea Harriers and virtually never saw the British kill shot being taken until it was too late to defend.

These narratives point to a clear trend in regard to first shot opportunity. Single-role fighter forces in all cases were consistently able to achieve first shot opportunities on their opponents. The 23rd Fighter Group, as a multi-role unit with a partial air-to-air emphasis, also achieved first shot opportunities on the majority of engagements. Conversely, multi-role fighter units consistently did not achieve first shot opportunities. Therefore, based on this measure, single-role air-to-air fighter forces are the most effective in air-to-air combat operations.

Percentage of Engagement Time Offensive/Defensive

The basic premise behind this measure is that it is better to be offensive than defensive. Since one is much more likely to survive on the offensive and can only attrit the enemy when on the offensive, there is general agreement on the truth of this premise. Therefore, fighter units that find themselves mostly on the offensive as measured over a period of time are considered more effective than those that find themselves predominately defensive.

In much the same manner as with "first shot opportunity," I have researched combat narratives to arrive at an overall assessment for each of the fighter forces in relation to time spent offensive or defensive. Since it is not possible to determine a specific percentage of time spent in each category, this assessment indicates simply whether each force was mostly on the offensive or mostly on the defensive. These determinations are represented in Table 8.

The discussion presented for "first shot opportunity" is equally relevant for this measure. My research, as well as my own experience, makes clear that air-to-air engagements are seldom long in duration. Therefore, the pilot or crew that gains the initial advantage and is first able to employ ordnance is usually the victor in the engagement. To be sure, mistakes have been made in the past and roles have been reversed, but this is relatively seldom the case. Rather, most air-to-air kills in all wars have been made against

aircraft whose crews never saw the attack until it was underway.

Table 8. Engagement Time Offensive Or Defensive

UNIT	TYPE UNIT (Single-role or Multi-role)	ENGAGEMENT TIME (Offensive or Defensive)
AVG FLYING TIGERS	SINGLE	OFFENSIVE
4TH FIW F-86 SQUADRONS	SINGLE	OFFENSIVE
USN F-8 SQUADRONS	SINGLE	OFFENSIVE
ISRAELI MIRAGE SQUADRONS	SINGLE	OFFENSIVE
BRITISH HARRIER SQUADRONS	SINGLE	OFFENSIVE
23RD FIGHTER GROUP	MULTI	OFFENSIVE
MULTI-ROLE UNITS - PACIFIC	MULTI	NEITHER
MULTI-ROLE UNITS - KOREA	MULTI	DEFENSIVE
MULTI-ROLE UNITS - VIETNAM	MULTI	DEFENSIVE

Therefore, for the same reasons addressed in the previous section, forces that were able to gain the first shot opportunity were also those that spent the majority of engagement time on the offensive. Similarly, those forces that did not gain the first shot opportunity also spent the majority of engagement time on the defensive.

Only in the case of the multi-role units in the Pacific during World War II have I made a different determination. In this case, the accounts of so many thousands of engagements that occurred in so many different ways do not support a conclusion one way or the other. For

this reason, and because of the relatively even exchange of kills with the enemy, I have concluded that engagement time for these forces was distributed roughly equally between the offense and defense.

This measure definitely indicates that single-role air-to-air fighter forces spent the majority of engagement time on the offense. Conversely, multi-role fighter forces spent the majority of engagement time on the defense. Therefore, based on this measure, single-role air-to-air forces are determined to be most effective in air-to-air combat.

Shots Per Engagement

This criterion of effectiveness has typically been used to evaluate offensive potential in air-to-air combat. Like the two previous measures, the underlying thought is that a unit that takes more shots is displaying more of an offensive nature than a unit that takes fewer shots and will, therefore, kill more enemy aircraft and sustain fewer losses. Examined over the course of time, therefore, this measure should provide a gauge for determining relative air-to-air combat effectiveness.

While conducting my research, I found that data on this measure can generally be found only for units that primarily focused on air-to-air combat. This is not surprising given that multi-role fighter forces are generally more concerned with statistics relating to their ground

attack missions, such as the tonnage of bombs dropped or the number and types of targets destroyed. Therefore, I have again blended empirical data and subjective analyses to draw conclusions relative to this measure of effectiveness.

Table 9. Shots Per Engagement

UNIT	TYPE UNIT (Single-role or Multi-role)	SHOTS PER ENGAGEMENT
AVG FLYING TIGERS	SINGLE	>.95:1
4TH FIW F-86 SQUADRONS	SINGLE	.45:1
USN F-8 SQUADRONS	SINGLE	>.70:1
ISRAELI MIRAGE SQUADRONS	SINGLE	>1.0:1
BRITISH HARRIER SQUADRONS	SINGLE	1.13:1
23RD FIGHTER GROUP	MULTI	UNKNOWN
MULTI-ROLE UNITS - PACIFIC	MULTI	LOW
MULTI-ROLE UNITS - KOREA	MULTI	LOW
MULTI-ROLE UNITS - VIETNAM	MULTI	LOW

As shown in Table 9, the shot per engagement ratios for the various units vary significantly. Therefore, each will be discussed in some detail to better clarify the relationships between them.

The ratios shown for the AVG Flying Tigers, Navy F-8 squadrons, and Israeli Mirage squadrons are all based on the respective kill per engagement ratios of these forces. Because no weapons system has a Pk of 1.0, not every weapon fired will impact its target. Over an extended period of

time, such as that occurring in war, more weapons will always be fired than the number of targets destroyed. For this reason, the shot per engagement ratios for these forces are listed as being greater than their respective kill per engagement ratios.

To illustrate the impact of Pk, consider the following. The Pk of gun systems during Linebacker I in Vietnam was 50%.⁸ This Pk was roughly the same experienced by the British in the Falklands and seems to be fairly consistent among all forces when a single gun shot is interpreted as being multiple trigger squeezes made on the same pass. On the other hand, Pks for both the AIM-9 infrared missile and the AIM-7 semi-active radar guided missile during this same Linebacker period were only 10%.⁹ But with the newer technology AIM-9L used by the British in the Falklands, the Pk was an excellent 88%.¹⁰

Therefore, when weapons systems Pks are taken into account, the probable shots per engagement of these three forces is much higher than shown. For the AVG and the Israeli Mirage squadrons, both of which had only gun kills, the shot per engagement ratios would both be approximately 2.0:1. For the Navy F-8 squadrons, which had both AIM-9 and gun kills, the ratio is closer to 4.0:1 to 5.0:1.

Because of the relatively small number of engagements experienced by the British Harrier squadrons in the Falklands, the exact number of shots taken is known. This

ratio is somewhat lower than the others due, as discussed previously, to the increased lethality of the technologically advanced AIM-9L missile.

The ratio of .45:1 for the F-86 squadrons in Korea is misleading because of the way in which an engagement was defined. Obviously, the liberal definition of this term as used in Korea would produce a lower ratio than those obtained in other conflicts. Just how skewed this ratio is cannot be determined. However, it can be concluded that the number of shots taken, when using a more strict definition of engagement, was definitely higher than that indicated.

For the multi-role fighter forces in Vietnam, the same comparison of kills per engagement and weapons Pk can be made. The ratio of missile kills to gun kills among these forces in Vietnam was roughly 2 to 1.¹¹ Therefore, given a kill per engagement ratio of .20:1 and the Pks discussed, the resulting shot per engagement ratio for these forces is approximately .35:1.

For the multi-role forces in Korea, my solely subjective conclusion is that they had relatively few shots per engagement. Their general failure to obtain the first shot opportunity, the primarily defensive nature of their engagements, the assessment of few kills per engagement, and a kill-to-loss ratio of 1:3, all indicate a fighter force that simply lacked the opportunities to take large numbers of shots in their engagements.

Using the same methodology, I concluded that the 23rd Fighter Group achieved a relatively high ratio of shots per engagement. Because they generally obtained the first shot opportunity, most often operated from an offensive posture, and achieved a relatively high kill-to-loss ratio, the group probably had ample opportunities for shots during their engagements.

Because of the mixed nature of their operations and a lack of data, I can reach no definitive conclusion on the shots per engagement achieved by the multi-role fighter forces in the Pacific during World War II. Given the trend established by the other forces, however, it is probable that the shot per engagement ratio of these forces falls nearer the other multi-role forces than those of the single-role forces.

The analysis of this measure indicates that single-role air-to-air fighter forces have consistently achieved higher shot per engagement ratios than those of multi-role fighter forces. Although weapons system Pk has a definite impact on the number of shots required to effect a kill (e.g., the high Pk of British AIM-9Ls in the Falklands), this trend remains valid. Also, these ratios are consistent with determinations of offensive potential identified by other measures. Therefore, based on this measure, I conclude that single-role air-to-air fighter forces are the most effective in air-to-air combat.

Percentage of Shots Valid at Launch

In conducting my research, I found almost no combat data relative to this measure of effectiveness. In retrospect, the reasons for this have become more obvious to me. In training, fighter units evaluate simulated shots based solely on whether or not the shots were taken in valid firing parameters. Since no live missile or gun is actually fired in training, evaluating the results of the shot is not possible. Therefore, one can only record the moment of the firing on film and use this launch picture as an educated guess as to how effective an actual weapon would have been.

In combat, however, those involved are more concerned with the bottom line of weapons effectiveness, which is measured by Pk. Because shot validity at launch is only one of many factors which together determine Pk, combat records do not record this particular piece of data. Rather, this measure is simply overshadowed by the more all-encompassing combat measure of weapons Pk.

Also, fighter pilots in all conflicts have routinely fired for effect, knowing they were not in valid firing parameters. By doing so, they have often been able to intimidate enemy pilots and lead them to make mistakes which could be capitalized on with valid shots. Therefore, this criteria has been viewed as having little relevance to air-to-air combat effectiveness.

The common thread to these arguments against using this measure for combat operations is the peacetime nature of this criterion. Because it is the best way we have in training, when weapons are not actually fired, to approximate actual weapons performance, this measure is widely used. But in combat, when weapons are fired for other reasons and when Pk becomes more relevant, the measure of shots valid at launch becomes less important.

Yet another problem with the use of this measure in combat involves the nature of air-to-air gun employment. With tracer rounds to mark bullet flight path, pilots in combat have generally opened fire, watched where the bullets were going relative to the target, and then "walked" the bullet stream into the target. All such shots would be defined as invalid at launch and, therefore, present an erroneous conclusion about combat effectiveness.

All of the shots taken by the AVG, the 23rd Fighter Group, multi-role forces in the Pacific during World War II, and the Israeli Mirage squadrons in the 1967 War, were gun shots. Also the vast majority taken by the F-86 squadrons and the multi-role forces in Korea were also gun shots. Therefore, for the reasons discussed, the measure of "percent of shots valid at launch" has no real relevance to these forces.

For the F-8 squadrons and multi-role forces in Vietnam, data relative to this measure is not available.

This leaves the British Harrier squadrons in the Falklands as the only force for which information is available. Again, because of the limited nature of this air war, the British only fired a total of 25 AIM-9L missiles, 23 of which were valid at launch.¹²

Table 10. Percentage Of Shots Valid At Launch

UNIT	TYPE UNIT (Single-role or Multi-role)	PERCENTAGE OF SHOTS VALID AT LAUNCH
AVG FLYING TIGERS	SINGLE	NOT APPLICABLE
4TH FIW F-86 SQUADRONS	SINGLE	NOT APPLICABLE
USN F-8 SQUADRONS	SINGLE	UNKNOWN
ISRAELI MIRAGE SQUADRONS	SINGLE	NOT APPLICABLE
BRITISH HARRIER SQUADRONS	SINGLE	92%
23RD FIGHTER GROUP	MULTI	NOT APPLICABLE
MULTI-ROLE UNITS - PACIFIC	MULTI	NOT APPLICABLE
MULTI-ROLE UNITS - KOREA	MULTI	NOT APPLICABLE
MULTI-ROLE UNITS - VIETNAM	MULTI	UNKNOWN

As indicated by the information presented in Table 10, the limited data available is insufficient for supporting any conclusion on combat effectiveness. Rather, the more significant finding of this portion of my research is that this criterion, while useful for training operations, has little practical relevance to air-to-air combat operations.

Kills Per Firing Attempt

This measure is concerned only with the final phase of an air-to-air engagement and relates the number of kills achieved to the number of attempts made to do so. The mechanism for comparing these shots and kills is weapons system Pk. Therefore, in contrast to the previous criterion, this measure is more suited for a study of actual combat operations.

In some cases, I have been able to locate exact numbers to determine kill per firing attempt ratios. In other cases, I have used the information presented previously on kills per engagement and weapons Pks to indirectly determine these ratios. The results are shown in Table 11.

With the exception of the Navy F-8 squadrons in Vietnam, the kill per firing attempt ratios for all of the single-role fighter forces are fairly consistent, varying between .47:1 and .71:1. The low ratio for the F-8 squadrons is explained by the fact that most shots were made with early generation AIM-9 missiles, which had very low Pks of approximately 10%. This situation differs from those forces that achieved all kills with the gun, as well as from that of the British, who achieved most of their kills with the much more lethal AIM-9L missile.

Table 11. Kills Per Firing Attempt

UNIT	TYPE UNIT (Single-role or Multi-role)	KILLS PER FIRING ATTEMPT
AVG FLYING TIGERS	SINGLE	.48:1
4TH FIW F-86 SQUADRONS	SINGLE	.47:1
USN F-8 SQUADRONS	SINGLE	.18:1
ISRAELI MIRAGE SQUADRONS	SINGLE	.50:1
BRITISH HARRIER SQUADRONS	SINGLE	.71:1
23RD FIGHTER GROUP	MULTI	UNKNOWN
MULTI-ROLE UNITS - PACIFIC	MULTI	LOW
MULTI-ROLE UNITS - KOREA	MULTI	.06:1
MULTI-ROLE UNITS - VIETNAM	MULTI	LOW

During the period in which the multi-role fighter forces in Korea achieved their 14 kills, they also claimed 124 enemy aircraft as having been damaged. If one assumes that these figures represent every firing attempt (i.e., 138 total shots taken), then the resulting kill per firing attempt ratio would be approximately .11:1. However, knowing that the Pk of gun shots averaged roughly 50%, at least twice the number of shots must have been taken. Taking this into account yields a kill per firing attempt ratio of .06:1.

Because the assessment made for the number of shots per engagement taken by the multi-role forces in the Pacific and the multi-role forces in Vietnam was largely a subjective one, I can only conclude in the same manner that the kill per

firing attempt ratios of these forces are also low. Similarly, I lack data altogether on the shots per engagement taken by the 23rd Fighter Group and, therefore, can form no conclusion here.

Single-role air-to-air fighter forces, with one exception, had consistently high kill per firing attempt ratios. The lower ratio of the Navy F-8 squadrons is at least partially explained by low weapons system Pk. Still, this ratio is three times as high as that of multi-role fighter forces in Korea, which employed a higher Pk weapon, the gun. The remaining multi-role forces are judged to have had low ratios, although the exact figures are not known. On balance, then, this information indicates that single-role fighter forces are the most effective in conducting air-to-air combat operations.

Air-to-Air Related Accidents

Information on air-to-air related accidents in combat is sporadic at best. Unless such incidents are witnessed by others or survived and later related by the mishap pilot himself, no one can be sure why a particular aircraft was lost. Even when seen by others, determining why an accident occurred often involves unsubstantiated guesswork by the observer. Instead, such accidents have typically been lumped with other unexplainable occurrences into a "cause unknown" category. In fact, the Air Force Safety Agency has never even attempted to keep such records of combat losses.¹³

The only fighter force for which data is available is the British Harrier contingent in the Falklands. Although several accidents did take place, none were attributed to any of the air-to-air related activities discussed in Chapter Two. Therefore, the general lack of applicable information makes it impossible to make a conclusion on relative air-to-air combat effectiveness based on this measure alone.

Incidence of Fratricide

Finally, little information is recorded anywhere concerning incidence of fratricide. Again, I found data only on the British Harrier squadrons, which reported no such occurrences. Fratricide is simply so difficult to substantiate and is such a sensitive issue for those involved that it is doubtful that completely accurate records exist in this area. Therefore, just as with air-to-air related accidents, I can make no conclusion on relative air-to-air combat effectiveness based on this measure alone.

Mission Objective Accomplishment

This is the final measure of effectiveness and is supported by all of the subjective commentary detailed in Chapter Three. Those who have been involved with this issue have been deeply concerned with the true bottom line, which is simply the ability to successfully accomplish the objectives as set forth for each mission. Long-term exposure to and, in most cases command of, fighter forces have formed

the knowledge base from which airpower experts have formed their opinions about the most effective way to organize for and conduct air-to-air combat operations.

To a large extent, the result of the subjective analysis is self-evident. Had the failure of multi-role fighter forces to perform as expected and desired not been recognized, the issue of fighter forces specializing in air-to-air combat would never have arisen. But this lack was evident, and airpower experts over the last twenty years have consistently argued in favor of fighter forces specializing in air-to-air operations.

The fundamental deficiency recognized by these experts was the inherent inability of multi-role fighter forces to excel in all things. Pilots and aircrews, given a finite amount of available flying time, simply could not maintain proficiency in the host of air-to-ground and air-to-air tasks required of them. Something had to give, and because air-to-ground tasking was clearly emphasized, air-to-air combat capability suffered.

As a result, the Air Force completely realigned its operational training system in 1974, and assigned each fighter squadron a primary mission area of either air-to-ground or air-to-air, but not both.¹⁴ Those multi-role fighter squadrons designated with a primary mission of air-to-air were required to allocate at least 70% of their training time and resources to air-to-air combat.¹⁵ In

effect, the Air Force was producing one of the single-role air-to-air fighter forces defined in Chapter One. When the F-15 became operational, the Air Force gained the second type of single-role force as well.

The need for such forces was recently reinforced by a 1993 Air Force Armstrong Laboratory study of a typical multi-role F-16 squadron with a primary mission of air-to-ground. A common theme expressed by pilots in this study was that the squadron suffered from a "jack-of-all-trades, master-of-none" syndrome.¹⁶ Further, when asked what aspect of the mission needed more emphasis, 76% of the pilots responded with air-to-air combat related answers.¹⁷ Also, squadron pilots stated that the single most difficult aspect of maintaining mission readiness was retaining proficiency in air-to-air combat.¹⁸

Finally, that these conclusions are purely subjective in nature does not make them any less valid. In reviewing his research efforts of the war in Vietnam, Frank Futrell commented that "when all was said and done, judgments of effectiveness were gut feelings based on long-term professional observation."¹⁹ Similarly, General Momyer summed up his experiences by saying, "I think we can measure how well our weapons perform, how well our pilots do and how good our doctrine is, but how effective we are remains a subjective matter."²⁰

Overwhelmingly, airpower experts are in agreement that fighter forces dedicated to a specific mission are more effective in that mission than fighter forces employed in multiple mission areas. Based on this assessment of mission objective accomplishment, I conclude that the single-role forces were the most effective, and the multi-role forces were least effective in conducting air-to-air combat operations. I also conclude that the 23rd Fighter Group, which placed a somewhat higher emphasis on air-to-air than the other multi-role forces, attained a level of effectiveness between that of the two other forces.

Summary

The results of all of the preceding analyses, shown in Table 12 at the end of this section, show that six of the ten objective measures support a conclusion favoring single-role fighter forces as being the most combat effective in air-to-air operations. The data supporting the "percentage of engagements survived" measure supports neither single-role nor multi-role forces. Two of the three remaining measures support no conclusion due to a lack of data. And the last measure, "percentage of shots valid at launch," supports no conclusion primarily because of the irrelevance of the measure to the issue of combat effectiveness. No measures support multi-role forces.

Although I have not attempted to attach any specific weighting to each of the measures, some are certainly better

indicators of combat effectiveness than others. Because of the all-encompassing nature of "kill-to-loss ratio," which takes into account all phases of the air operation, I believe this measure to be the most significant of all objective measures.

I place "first shot opportunity" and "percentage of engagement time offensive or defensive" next in priority. Both of these measures present an overall picture of how well each force was able to gain and maintain an offensive posture. Since one's offensive posture denies shot opportunities to the enemy and at the same time provides the potential for killing this enemy, the force that best establishes this offensive status should prevail over time.

In terms of providing another general picture of combat effectiveness, the "percentage of engagements survived" measure is important for evaluating the defensive aspect of an engagement. Nevertheless, this criterion only measures one phase of the entire air-to-air battle and, therefore, is of lesser importance than the preceding three.

The other measures that are supported by empirical data also represent only a limited portion of the overall engagement. Further, as described during the earlier analyses, the numbers alone can sometimes paint an inaccurate picture of actual effectiveness. These measures, then, fall next in priority.

Finally, the "air-to-air accidents" and "incidence of fratricide" measures, while certainly useful for evaluations

of combat operations, are probably the least important in terms of describing overall air-to-air effectiveness. Therefore, it is neither surprising nor critical to this research that information supporting these measures is absent.

Adding these considerations of weight to each of the measures indicates that the three most important measures support single-role forces as being the most combat effective. The "percentage of engagements survived" measure, which comes next in priority, supports neither single-role or multi-role forces as being more effective than the other. Three of the four purely empirical measures support single-role forces, while the fourth is supported by insufficient data from which to draw a conclusion. The remaining two measures, lowest in priority, are also not supported by sufficient data.

Together, these objective measures clearly support the conclusion that single-role fighter forces are the most effective in conducting air-to-air combat operations. These forces are consistently better than multi-role forces in creating first shot opportunities, maintaining the offensive, employing ordnance, and ultimately killing the enemy.

The subjective analysis of the ability of various fighter forces to accomplish mission objectives also strongly favors single-role fighter forces. Because this subjective analysis, which is arguably the more important of the two, is

in agreement with the objective analysis, the only overall conclusion that can be drawn from this research is that single-role air-to-air fighter forces are more effective than multi-role forces in the conduct of air-to-air combat operations.

Table 12. Summary of Measures of Effectiveness

CRITERIA	UNITS	FLYING	23RD FTR	USAF IN	4TH FW	US NAVY	US MULTI-	ISRAELI	BRITISH	MOST COMBAT EFFECTIVE (SINGLE-ROLE OR MULTI- ROLE FIGHTER UNITS)
		TIGERS IN CHINA: WW II	GROUP IN CHINA: WW II	PACIFIC THEATER: WW II	F-86 SQUADRONS: KOREA	F-8 SQUADRONS: VIETNAM	ROLE UNITS: KOREA	AFRAGE SQUADRON: 1987 WAR	HARRIER SQUADRONS: FALKLANDS	
KILL-TO-LOSS RATIO		50:1	5.0:1	1.98:1	10:1	0.3:1	1:3	20:0	23:0	SINGLE-ROLE
KILLS PER ENGAGEMENT		.98:1	UNKNOWN	UNKNOWN	.21:1	.70:1	LOW	≥1.0:1	.80:1	SINGLE-ROLE
% ENGAGEMENTS SURVIVED		99%	HIGH	LOW	99%	89%	HIGH	100%	100%	NEITHER
FIRST SHOT OPPORTUNITY		YES	YES	NO	YES	YES	NO	YES	YES	SINGLE-ROLE
ENGAGEMENT TIME: OFF OR DEF		OFFENSIVE	OFFENSIVE	NEITHER	OFFENSIVE	OFFENSIVE	DEFENSIVE	OFFENSIVE	OFFENSIVE	SINGLE-ROLE
SHOTS PER ENGAGEMENT		>.98:1	UNKNOWN	LOW	.46:1	>.70:1	LOW	>1.0:1	1.13:1	SINGLE-ROLE
% OF SHOTS VALID AT LAUNCH		N/A	N/A	N/A	N/A	UNKNOWN	N/A	N/A	92%	UNKNOWN
KILLS PER FIRING ATTEMPT		.46:1	UNKNOWN	LOW	.47:1	.18:1	.06:1	.50:1	.71:1	SINGLE-ROLE
AIR-TO-AIR ACCIDENTS		UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	NONE	UNKNOWN
INCIDENCE OF FRATRICIDE		UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	NONE	UNKNOWN
MISSION OBJECTIVE ACCOMPLISHMENT		MOST EFFECTIVE	PARTIALLY EFFECTIVE	LEAST EFFECTIVE	MOST EFFECTIVE	MOST EFFECTIVE	LEAST EFFECTIVE	MOST EFFECTIVE	MOST EFFECTIVE	SINGLE-ROLE

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

Conclusion

This thesis has dealt with the issue of air-to-air combat effectiveness. Specifically, fighter forces dedicated to air-to-air operations and multi-role fighter forces with air-to-air tasking as only one of several missions have been compared and evaluated.

The basis for comparison of the fighter forces has been their respective performance as measured by ten objective and one subjective criteria. Each of these criteria evaluates either the entire scope of air-to-air engagements or significant portions of the whole. Information used to support these measures has been presented in the form of accounts of past combat operations, as well as subjective assessments relative to the overall issue of air-to-air combat effectiveness.

The analysis conducted in this thesis has shown that single-role air-to-air fighter forces have consistently outperformed multi-role fighter forces as measured by most of the criteria and by all of the most significant ones. These single-role forces have either been created from the beginning to perform only air-to-air missions or have

transitioned from a multi-role status to a dedicated focus on air-to-air combat. As a result, these forces have been the best at gaining and maintaining an offensive advantage over enemy aircraft and using this advantage to achieve many more kills than the losses they suffered in the process.

Therefore, the overall conclusion of this thesis is that single-role air-to-air fighter forces are more effective than multi-role fighter forces in the conduct of air-to-air combat operations.

Recommendations

This thesis points out the need for further research in two separate but related areas. The first is the ability to conduct the research itself. Wayne L. Waag, a researcher with the USAF's Armstrong Laboratory, has pointed out that in regard to evaluations of combat effectiveness:

It is clear that one of the major obstacles, especially in the air combat arena, is the lack of reliable and valid measures of performance...another real-world constraint is that the amount of data available for evaluation will always be severely limited.¹

My own experience in writing this thesis confirms the truth of this statement. If we are to learn from our experiences of the past so that lessons can be readily discerned and applied to future operations, we must facilitate an easy and simple research approach. Therefore, I recommend the following:

a. A standard set of measures of air-to-air combat effectiveness should be developed. These measures should cover all phases of the air-to-air engagement continuum and should be supportable by easily obtained post-mission debrief information.

b. Once developed and agreed upon, a method should be developed for institutionalizing these measures in our air forces so that the required combat data is actually recorded.

The second area requiring further research is the impact of current DOD initiatives to multi-missionize all U.S. fighter forces. The Navy no longer employs dedicated, single-role air-to-air fighter forces, and the Air Force has plans to multi-mission task all fighter forces in the near future. Additionally, the Air Force has already acknowledged that the F-22 stealth fighter, originally planned to be employed in the air-to-air role only, will enter the inventory in a multi-role capacity.

Nevertheless, the need for highly proficient air-to-air combat forces promises to remain as critical as ever in future battles for aerospace control. Therefore, several questions merit further research.

a. Given the world-wide proliferation of sophisticated and highly lethal fighter aircraft, what capabilities must U.S. fighter forces possess to ensure aerospace control can be obtained in any future conflict?

b. With both the Air Force and the Navy moving to all multi-role fighter forces, how much of these forces must be assigned a primary role of air-to-air to help ensure aerospace control can be achieved when needed?

c. For those forces assigned the air-to-air role as their first priority, how much of the total training schedule must be devoted to air-to-air operations to maintain proficiency in this type of combat?

d. Given that future U.S. military operations will become increasingly joint in nature, can one service be tasked to provide air-to-air assets for all, or at least most, future joint operations?

e. If one service carries out all air-to-air missions in support of the operations of all services, will this free up fighter assets from the other services for other missions? Will specialization again be possible?

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Chapter 1

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